POWER PLANT ENGINEERING

Established Over 29 Years

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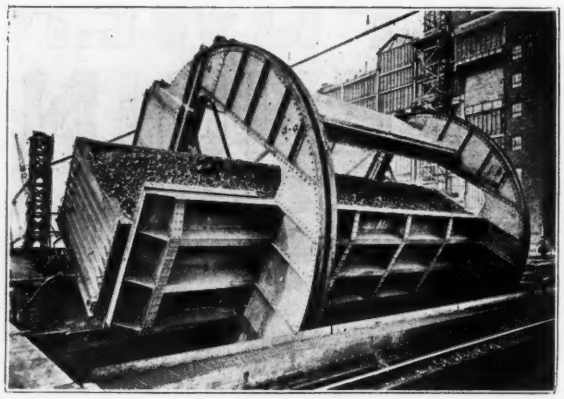
Feeling the Turbine's Pulse

JUST BECAUSE a turbine is large and rugged and made of steel, don't get the idea that it is immune to disease or that it is never afflicted with slight ailments. The turbine has its bad days like anyone else, especially when it is new and still in the factory on the testing floor. Bolts have been drawn too tight or not tight enough, governors are not adjusted just exactly right, bearing caps press down too hard, moving parts are stiff and not fitted to each other—all these things and many others make smooth running during the first few days of a turbine's life somewhat difficult. So a corps of trained physicians, in the factory they call 'em "test men," are in constant attendance, taking the turbine's temperature here, feeling its pulse there, feeding it doses of oil (no, not castor oil), in short, doing everything possible for its comfort. Here, for instance, we see them at work on a new General Electric Co. turbine listening to tiny sounds within the casing by means of slender steel rods which serve as stethoscopes. Surely a worthy occupation—safeguarding the turbine's health, so to speak.



The Year's Achievements

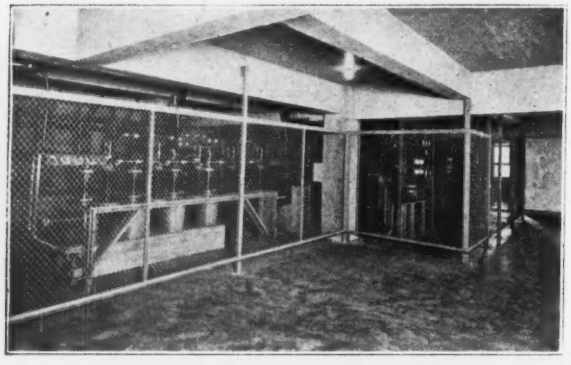
PHOTOGRAPHS TAKEN FROM PLANT ENGINEERING SHOW

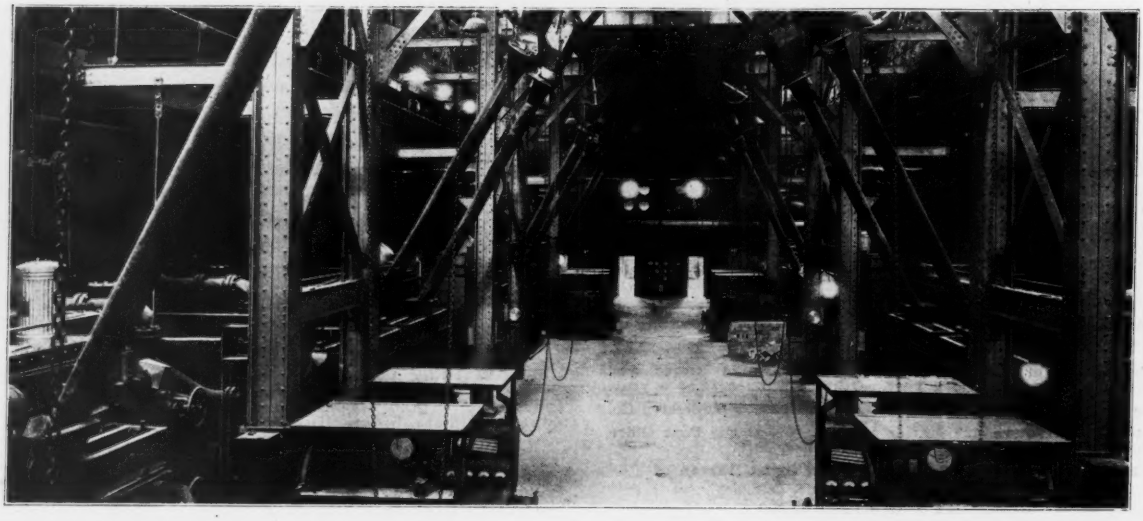
Nothing is so satisfying during the course of a long journey as to stop occasionally on one of the high prominences over which the trail leads and to look back over the territory traversed. There, in one brief glance, we see spread before us, all the weary miles over which we came and, as we thus survey the view, we feel, in a measure, repaid for our efforts and forget the hardships and difficulties which beset the trail.

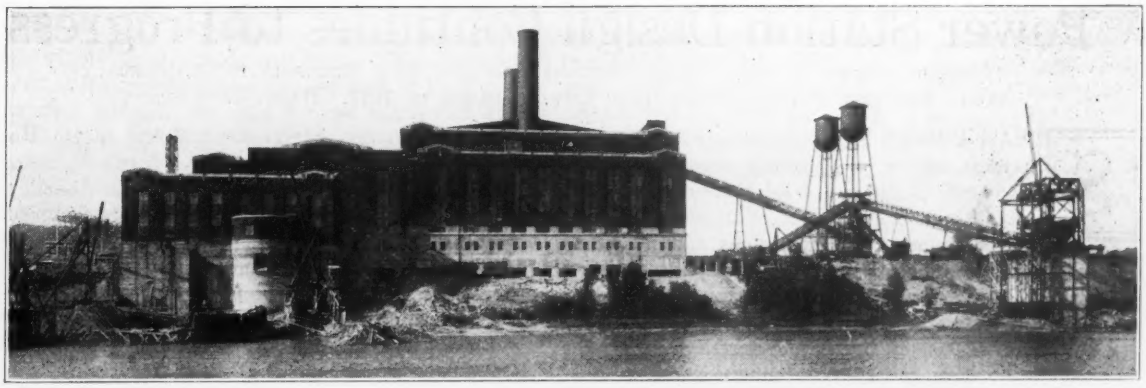
It is with similar feelings as we approach the close of the year that we pause to review the year's progress in our respective fields of endeavor. In the power plant field, while it is obviously impossible to show pictures of all the various achievements in design, on two pages, or, for that matter on a thousand pages, the photographs on these pages show a number of the more important developments.

In the upper right of this page for instance is shown a rotary car dumper at Cahokia. This method of unloading coal is rapid, convenient and has become the standard method at many of the larger stations.

Where the price of coal is high or where fuel oil is plentiful, the latter fuel has been successfully applied in the operation of central stations. The upper left photograph shows the Seal Beach Station which is one of the larger stations using oil as fuel.







In Power Station Design

THE YEAR'S PAGES OF POWER
ADVANCES IN STATION DESIGN

For testing electrical cables, transformers, insulators and other electrical equipment, the use of direct current has found great favor. In the left center view is shown the Kenotron Rectifier room at Crawford Ave. which produces direct current at potentials as high as 200,000 v.

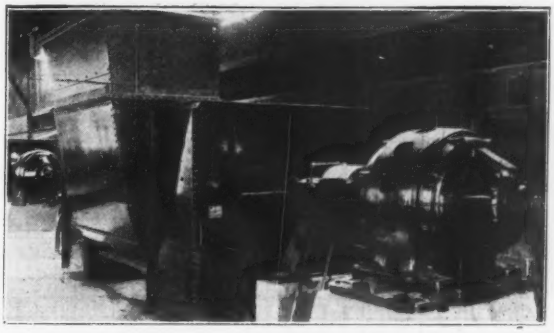
The boiler room at Philo, shown at the lower left, is of interest because of the elaborate methods of steam control and the method of reheating steam after it has passed through the high pressure stages of the turbines.

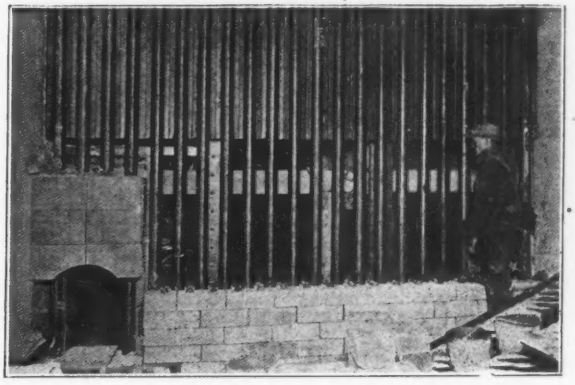
At the upper right is a view of the new Columbia Station, one of the large pulverized coal plants placed in operation during the year.

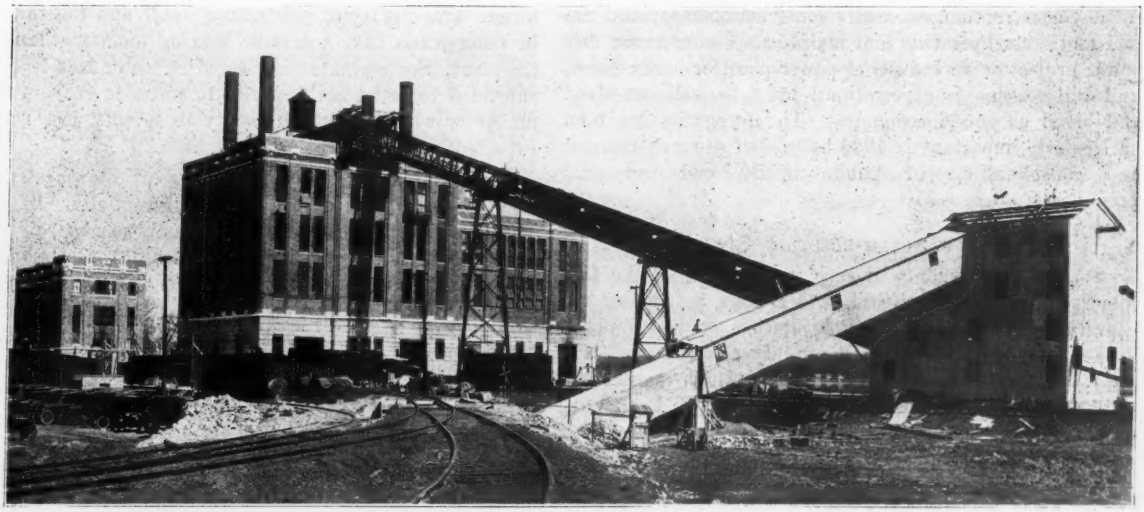
Electric drives for auxiliaries have received constantly increasing application, and a typical installation as applied to an induced draft fan is shown at the right.

Another development of great interest is the water cooled furnace wall also shown at the right. This is a view inside one of the furnaces at Hell Gate, and represents a trend in progress which seems to lead us back to the old Scotch boiler idea.

Below is a view of the Riverside Station at Davenport, Iowa, in which the turbines are bled at four points for preheating air and for heating feed water.



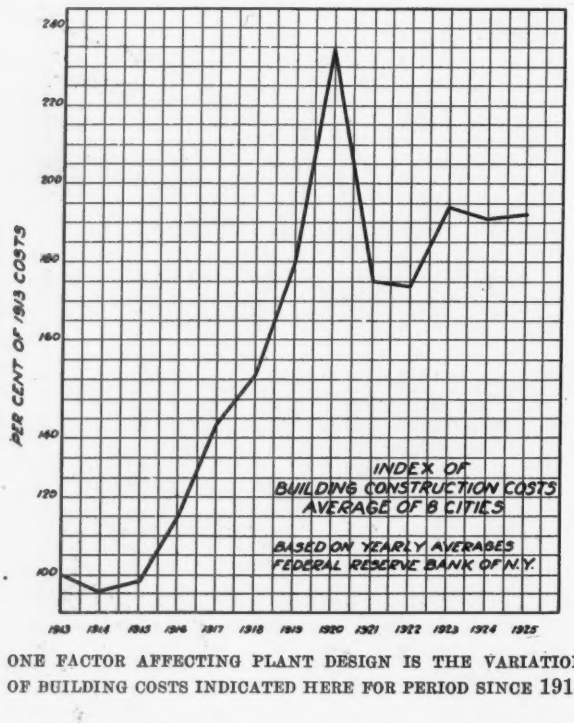




Power Station Design Continues to Progress

INTERCONNECTION OF GENERATING STATIONS PRESENTS NEW PROBLEMS TO DESIGNERS; B.T.U. REQUIRED PER KILOWATT-HOUR CUT TO 16,000 IN 1925. BY P. JUNKERSFELD*

STEAM POWER STATION design today is not a mere matter of selecting apparatus nor a standardized cut and dried procedure that can be followed in every case. With the wide range of requirements and conditions and the availability of improved generating units, boilers, auxiliaries and switching equipment, the proper design of a modern steam-electric generating station is more and more a problem that affords considerable latitude for skill, experience and judgment. Due to the interconnections with other



ONE FACTOR AFFECTING PLANT DESIGN IS THE VARIATION OF BUILDING COSTS INDICATED HERE FOR PERIOD SINCE 1913

stations and systems, the rapid development in the art and correspondingly rapid obsolescence, the high costs of present day construction, especially construction labor and the fuel and other operating and maintenance conditions, any power project or an industrial power plant or boiler plant, to fulfill reasonable expectations, must be well conceived and based on sound economics. The foregoing has been particularly important in 1925 because of so many mergers and consolidations of public utility and industrial properties.

KINDS OF STEAM-ELECTRIC STATIONS

Service requirements in each case should be the first factor considered and should have a large bearing on the character of any steam electric station or boiler plant. These plants may be classified roughly as follows:

1. Central Steam Electric Station, which may be initially or successively a Total Load, Base Load, Peak Load or Standby Station.
2. Combination Steam and Hydroelectric Station.
3. Combination Steam Electric and Steam Heating Station.
4. Industrial Boiler Plant or Power Plant.

The design in each case will depend largely upon local conditions, output, peak load, load factor and if combined with or related to a hydroelectric project, stream flow, water storage available, extent of hydroelectric development and so forth. The securing of the lowest possible net B.t.u. per kw-hr. should not be the sole aim of the designer, but instead he should strive to obtain the lowest possible total cost of production, including fixed charges, per kw-hr. of output under conditions and service requirements encountered.

Industrial power plants occasionally are of as much capacity as small central stations. The service requirements vary greatly with different industries. If process steam is required, heat balances must be figured carefully to determine the proper installation to secure lowest costs of production. The installation of waste heat boilers and special prime movers carefully designed and selected with reference to the needs of the particular plant in some of our industries has tended to lower costs of steam production. Undoubtedly, many of our industries today have high steam costs due to inefficient operation of existing equipment and in some cases poorly designed plants for generating and utilizing steam, and the retention and operation of obsolete and inadequate equipment.

CONDITIONS AFFECTING DESIGN

Study of all essential factors is necessary before starting to design a steam electric station. After the service requirements have been ascertained the selection of a site will depend upon rail connections, soil conditions, condensing water facilities, available fuels, nearness to load, degree of reliability of service demanded, probable growth of load, relation to balance of system and to neighboring systems, labor conditions for construction and operation and other factors.

On account of the difficulty of finding sufficient condensing water available, plants of large capacity can be located only on the larger streams and lakes or at tidewater. The quality of condensing water and the variation in water levels have a definite bearing upon the design of the plant. Some plants are located at sea or lake level and subjected to say a ten foot rise in water level; others are on rivers where a rise of twenty to seventy feet may be expected.

Soil conditions affect the design of the substructure and the total cost of the plant substantially. In many recent cases good bearing soil was easily reached, in others piles thirty to seventy-five feet in length or caissons had to be used. Protection against water during construction and afterward is sometimes a large item. The conditions for no two plants are alike and careful analysis affords opportunity for savings. In some cases ratio of the substructure cost to superstructure cost is several times as great as in other cases.

Construction labor conditions and rates, the amount of unemployment, skilled labor supply available, means of transportation to and from the site, and the necessity for

*McClellan & Junkersfeld, Engineers, New York City.

boarding and lodging accommodations all have a bearing on suitable design. The index of building construction costs for eight cities in the United States as determined by the Federal Reserve Bank was 191 per cent of 1913 prices during 1924 and 192 per cent for ten months of 1925. The variation in building costs since 1913 as indicated by this index is shown in the accompanying curve. As the power house structure and sub-structure represents a substantial part of the total power house cost, advantage might be taken of any depressions in building construction as well as of temporarily reduced demands for mechanical and electrical equipment rather than to wait until demands of service to the public force construction procedure on a rush and overtime basis.

Basic Design

After all the principal requirements and conditions are analyzed the first determination is usually the capacity of the main turbo generators. The most important, however, and the one requiring the most experience and judgment, in the determination of steam making surface for the particular steam demands during the hours of the year or series of years and whether these demands can be met by two boilers per unit or a large number. The possibilities for one boiler per unit are still very few.

Much thought and some experimentation are being devoted to reducing the physical dimensions of "boiler units," including furnace, boiler, superheater, economizer or air preheater or both, hence their cost and the size and cost of the boiler plant building. This is primarily a matter of introducing and mixing fuel and air and of complete combustion in the smallest furnace volume and of combining with the furnace the boiler, superheater, economizer and the air preheater. The possibilities of reduction in dimensions of these boiler units seem attractive especially with the better grades of bituminous coals.

The general arrangement of a power station may be high and narrow or low and wide, dependent on soil conditions or choice. The land is generally such a small proportion of the total cost that it does not enter into the consideration in design except in the congested portions of large cities where sufficient area cannot be obtained without paying prohibitive prices. Where the soil is filled in ground, or river silt, and it is necessary to go to some depth to secure substantial footings, the vertical arrangement is usually less expensive.

Major Problems of Design

The solution of steam pressure, temperature and type of heat balance problems has not changed much during the year. Turbines of 300 to 400 lb. per sq. in. total temperature 700 to 725 deg. F. and boilers to correspond are now standard equipment. Pressures of 550 lb. are used in a few cases and one 1200-lb. turbine has recently been put into service and another has been ordered. Regenerative and regenerative re-heating cycles have been tried out. The former with modifications as to the number and position of bleed points has an economic place and is being used in many plants. The latter is in use in three plants and has so far had only a short trial. The yearly average B.t.u. per kw-hr. for some of the largest and newest steam electric stations at intervals during the past twenty-five years is shown.

	1900	1905	1910	1915	1920	1924	1925
B.t.u./kw-hr...	37,500	30,100	25,900	20,100	19,000	17,000	16,000

The trend is still downward but at a less rapid rate. At each interval there were some stations having a better B.t.u. performance but very few with better performance over a 12 months' period with the variations in condensing water temperatures daily and monthly load factors and other adverse conditions.

(a) Feed Water Heating and Condensers.

Regenerative methods of feed water heating, namely, bleeding the turbine at one or more points, have in connection with the more efficient turbines, greatly improved the plant thermal efficiency and still further reduced the fuel consumption. This method of feed water heating is now being used extensively. Economizers are giving way in many instances or are used in combination with air preheaters. Evaporators of two or more effects can in most cases be justified for feed water make-up and are contributory in prolonging the service hours of boilers. Deaeration of feed water is advisable and in some designs is a necessity if excessive maintenance on certain equipment is to be avoided.

Condensers of the single pass type have been operated successfully and efficiently in several plants with resultant decrease in pumping power and give promise of wide application where abundance of condensing water and other conditions are favorable. Some high heat transfers have been obtained but only in exceptional cases can designs be based on these high rates of 600 B.t.u. and more per sq. ft.

(b) Boiler Units.

The trend toward larger capacity and higher ratings of boiler units has become more pronounced. In some instances the number of boilers has been reduced to two per generator. High rates of evaporation such as 500 to 600 per cent of boiler rating have been reached but only for periods of short duration. Continuous operation at these rates cannot be counted on at present. Boilers with longer tubes, up to 24 ft. in length, are in service and result in lower unit costs.

Design of the furnace, boiler, superheater, economizer, and or air preheater as a unit is quite a complicated study as each is a function of the other but affords large opportunities for reduction of investment cost as well as reduction in maintenance and fuel consumption. Remarkable monthly performances of 90 per cent efficiency and better have been secured with some of these arrangements. Air preheaters have been perfected mechanically. Operating difficulties have been encountered and maintenance costs are not yet ascertainable. Designs are now laid down for preheaters to give 500 deg. F. air at 500 and 600 per cent of boiler rating. The results of such an installation will be awaited with interest.

Furnaces are in more of an evolutionary state than ever before. This is particularly noticeable in pulverized coal fired plants. Starting with solid fire brick walls we have air cooled, water cooled, water cooled refractory combinations of the above and completely water cooled furnaces.

Examples of new furnaces put in service during the past year are the fin tube construction at Cahokia and the Bailey water cooled refractory lining at Ashley St. stations of the Union Electric Light and Power Co. of Illinois and Missouri.

Pulverized coal firing has made further strides in 1925 as evidenced by the increasing application among steam electric stations. A recent industrial installation of the central or storage system of pulverized coal is worthy of mention. This is at the Canadian International Paper

Company's plant at Three Rivers, Quebec. The preparation plant is located over 1200 ft. from the boiler plant and the pulverized fuel is pumped by the Fuller-Kinyon pumps. This is the first large plant to burn Nova Scotia coal in pulverized form.

Unit systems of pulverized coal firing have been installed in several existing plants and in a few small new industrial plants and with the exception of difficulties as are generally encountered in any trial installation, the results have been satisfactory.

The installation at Ashley Street previously mentioned shows the possibilities of increasing plant output with present equipment. Boiler output has been increased 50 per cent, efficiencies at equal ratings greatly improved and smoke satisfactorily reduced.

Sluicing of ashes is on the increase and is especially adaptable to high fusing ash from certain coals. With low grade coals having low fusing ash which has greater tendency to form large clinkers, the sluicing system is sometimes supplemented with provision for disposing of these occasional clinkers.

(c) Coal Handling.

Plants at tide water are usually provided with facilities for receiving and unloading coal shipped either by rail or water while those in the interior of the country even though on navigable streams are usually provided with rail unloading facilities only. During the past two years rotary car dumpers have come into extensive use for unloading, only one car being dumped at a time, the string of cars being uncoupled and run on the dumper either by gravity or spotted by a locomotive according to design.

(d) Auxiliary Drives.

Auxiliary drives for central steam electric stations and for base load plants are usually motors. These are now generally started on full voltage and the control has been simplified by the elimination of overload protection. The house generator if any is used is sometimes direct connected to the main turbo generator shaft or the station service auxiliaries are supplied by a three winding transformer in the generator leads.

Emergency supply for the essential auxiliaries is sometimes provided by non-condensing steam turbines or by a dual motor and turbine drive. One important new station design includes turbine drives normally for the essential auxiliaries with efficient turbines, some of which operate condensing.

Automatic control of combustion auxiliaries is receiving more attention and several systems are in service on pulverized coal, stokers and oil which greatly assist or make possible the remarkably high monthly boiler efficiencies obtained in some of these plants.

(e) Electrical Features.

The isolated phase arrangement still holds favor with many large metropolitan stations, some with vertical and others with horizontal separation of phases. Experience in some plants has indicated the advisability of enclosing bus sections in separate rooms, sealing up bushings and bus enclosures and feeder runs between rooms or floors where bare copper is used. Ventilation of these chambers is of primary importance and in some of the large stations ventilating ducts have been run to each chamber, the fans being controlled from the main control room. In a case of trouble it is important for the operator to know the section or sections affected. Means of indicating this and of automatically disconnecting generators and adjacent bus sections as well as all tie lines are being installed.

Use of auto transformers or of parallel winding transformers in the leads of generators has brought about the use of higher distribution voltages resulting in greater capacity of switching equipment, in feeders and in substations, a lesser number being required. The tendency is continuing toward outdoor switching structures where practically the entire output of the plant is transmitted over high voltage transmission lines.

Supervisory control although having had no extensive application other than for load indication and remote control of substations, offers possibilities for remote control of outdoor switching equipment.

The use of direct current for testing busses, conductors, disconnecting switches, oil circuit breakers and feeders is now accepted as standard, and practically all the large stations which are being designed or constructed today are provided with high voltage direct-current test sets permanently installed with connections so arranged that any section can be thrown over to the test bus.

Present Status and Trend

Recent designs trend toward higher pressures and temperatures, higher boiler unit ratings and greater over-all economy. The trend of efficiency is still upward but so also is the trend of fixed charges. The curve of the former is flattening out, whereas the latter is still steep and is the field where greater attention should be centered. Who can tell what another year will bring forth? It is useless to prophesy what changes will be made as the general tendency is to underestimate future progress. Much improvement is needed both in the quality of materials and in equipment to withstand higher steam pressures and temperatures, higher furnace temperatures and the abrasive and slagging action of pulverized fuel. Much experimental work is still necessary and many difficulties must be overcome before low temperature distillation of coal can be successfully coupled with central station practice.

Several large stations began initial operation during the year 1925. Among them might be mentioned the Holtwood Station of the Pennsylvania Water and Power Company, the Columbia Station near Cincinnati and the Edgar Station of the Boston Edison Company. Others had their formal opening this year, but began initial operation during 1924. The demand for additional capacity increases and many extensions are being made or contemplated to existing stations. There are also a number of new stations under construction. Included in this number are the Richmond Station of the Philadelphia Electric Company at Philadelphia, The Avon Plant of the Cleveland Electric Illuminating Company, the 14th Street Station of the New York Edison Company at New York, The Gould Street Station of the Consolidated Gas and Electric Company at Baltimore, and the new steam electric plant of the Southern Power Company near Charlotte, N. C.

The year 1926 should bring forth new developments and improvements in power station design. There is considerable activity among industrial enterprises to lower costs and increase production. This includes rehabilitation and extension of boiler plants. Public demands for electric power indicates need for construction of new and of enlarging and improving many existing stations. There seems to be especial need for care in keeping unproductive investment in equipment at a minimum and to otherwise protect any investment as far as the best available experience and judgment can suggest against the rapid obsolescence which is prevalent in the power station industry today.

Pulverized Coal Systems of 1925

GROWTH OF THE METHOD, TYPICAL RESULTS AND NEW DEVELOPMENTS. BY FREDERICK A. SCHEFFLER*

IT SHOULD be noted that 6 yr. ago technical and trade papers looked with suspicion on subject matter of this nature and handled it gingerly, although the authors were men who were in excellent standing as engineers. Technical and trade papers, even newspapers and weeklies, during the past 2 yr., have devoted considerable space to good, bad and indifferent articles but all helping the common cause, creating great interest among even the most laconic engineers in this country and abroad.

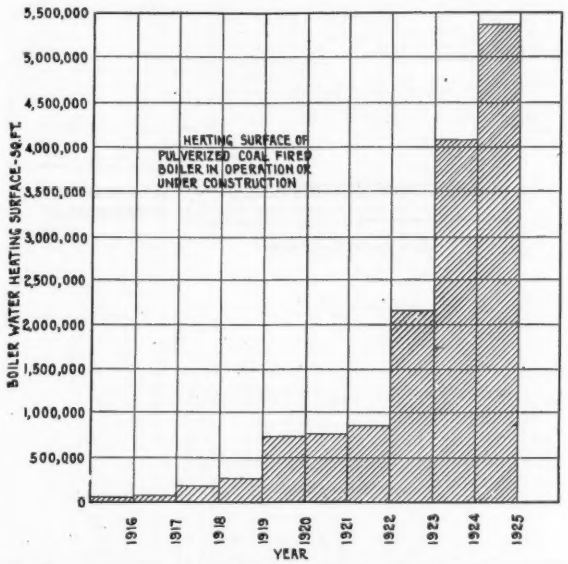


FIG. 1. GROWTH OF BOILER SURFACE USING PULVERIZED COAL

Furthermore, the most advanced engineering societies and organizations have commandeered their best men on committee work to investigate and report yearly on the best practice, changes in methods and efficiencies, so that there is always available through these channels data that is quite up to date for those who are really interested.

DEVELOPMENT IN 10 YEARS

Demand for pulverized coal as applied to boilers in power plants is so large that the installations (in operation and under construction) cover 5,000,000 sq. ft. of effective boiler heating surface and will easily develop 1,000,000 hp. Roughly speaking, this means, with 60 per cent load factor, 25,200 t. per day of 24 hr., or 7,560,000 t. per yr. The first commercially-successful boiler installation burned 120 t. per day. Figure 1 shows this phenomenal growth, particularly in the last 2 yr.

The writer can compare the remarkable advance of this industry, as applied to power plants, only with that of the use of steam turbines. Both have contributed inestimably to bring down coal consumption to present practice, —the low figure of less than 1¼ lb. of good coal per kw-hr. in moderate and fairly large power plants. In a prominent editorial on this subject, the "Outlook" of Jan. 7, 1925, says: "It is significant because it is permitting us to capture more of the latent energy that is contained in our coal than we have been capturing; also because it is bringing into practical commercial use some extremely inferior varieties of coal, which, heretofore, we have had to throw away."

PULVERIZED FUEL IS EFFECTIVE FOR INDUSTRIAL PLANTS

Public service plants have been fairly well described in detail in many technical papers, but little has been said about the vast and growing application in the industries, here and abroad. This is a field that cannot support the refinements adopted in the majority of the public service plants, principally because of the first cost involved in these refinements, the less effective help employed and the boiler feed water used; also because the cost of coal used to develop the power and process steam required is only a small percentage of the total cost of production of the finished product; whereas, in public service plants, coal cost may equal 50 per cent of the total cost of power production.

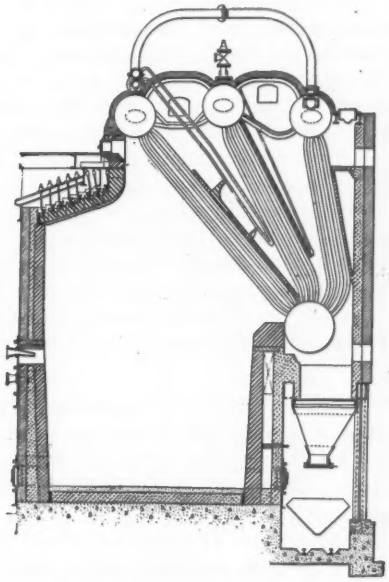


FIG. 2. STIRLING BOILER AND SETTING HAVING 5 HORIZONTAL BURNERS, BURNING 7500 LB. OF COAL AN HOUR

Simplicity in the design of the boiler furnace and equipment is, therefore, the prime requisite in an industrial plant, if efficient operation and low maintenance cost are not to be sacrificed. An excellent example of an installation of this nature is illustrated in Fig. 2, showing a boiler of 5000 sq. ft. effective heating surface, fired horizontally with five burners, having individual feeders and using a storage system.

This boiler plant when completed with its 8 boilers will replace a boiler house having originally 13 boilers. Several of the pulverized-coal fired boilers have been in operation from 2 to 3 yr. at much higher ratings than is customary for industrial plants. It is not unusual for these boilers to be operated at 300 per cent of rating for

*Manager Power Dept., Fuller-Lehigh Co., Fullerton, Pa.

24 hr. daily, equal to an evaporation of 10 lb. of water per square foot of heating surface per hour, and the monthly average is 275 per cent of rating. The coal used is average quality bituminous.

Regular operating results are shown in Table I, taken from the plant engineer's records:

TABLE I, TYPICAL RECORD IN PULVERIZED COAL PLANT

No. 4 Boiler Rating	CO_2	No. 5 Boiler Rating	CO_2	No. 6 Boiler Rating	CO_2	No. 7 Boiler Rating	CO_2	No. 8 Boiler Rating	CO_2
275	14.2	260	14.0	235	15.4	245	14.5	220	15.1
265	13.8	265	14.1	235	15.6	245	14.5	213	15.0
270	14.0	250	14.0	235	16.2	246	15.2	215	15.3
275	13.2	250	13.0	235	16.0	230	14.1	210	15.7
295	13.0	250	14.0	230	16.0	238	14.9	195	11.8
295	14.6	255	14.0	240	15.7	250	15.0	198	15.2
285	14.0	255	14.1	245	15.7	242	14.6	212	14.3
285	14.2	250	13.8	250	15.1	250	14.1	208	14.9
295	14.4	260	14.0	240	15.0	240	14.3	218	14.1
280	14.0	250	13.8	240	15.1	245	14.2	210	14.4
280	14.3	260	14.0	245	15.6	270	14.2	208	14.7
280	14.2	250	13.8	235	14.8	230	15.1	210	14.6
280	14.8	245	13.6	225	15.4	225	15.3	220	14.8
280	14.1	260	14.1	225	16.0	238	15.2	218	14.6
275	14.5	265	14.1	...	....	230	14.2	215	14.4

Several unique features of this installation are: 1. Simplicity in the furnace design; 2. Solid walls, the hollow rear wall delivering heated secondary air to the furnace, cooling this wall and the ashpit floor; 3. Horizontal firing, permitting low furnace setting for high ratings and requiring small furnace volume for predetermined operating conditions; 4. No ash hoppers, the furnace floor being practically level with firing floor and furnaces cleaned out each 8-hr. shift; 5. No water screens or complicated system of tubes in the furnace and no difficulty with slagging troubles; 6. Arrangement and number of burners planned to operate the boiler at maximum (over 300 per cent) rating, without impingement of flame on side or rear walls.

BURNER DESIGN IS IMPORTANT

In this last named feature lies the art of designing a successful boiler installation. The greater number of burners that can be properly installed, each burner using at maximum rating a minimum amount of coal and with low pressure and velocity of primary air—not over 3 oz. —will be sure to give excellent results with the best efficiency and keep down the maintenance of the brick setting. The best practice is to burn, for maximum ratings, 20 lb. of coal per minute per burner and, if this can be reduced, so much the better.

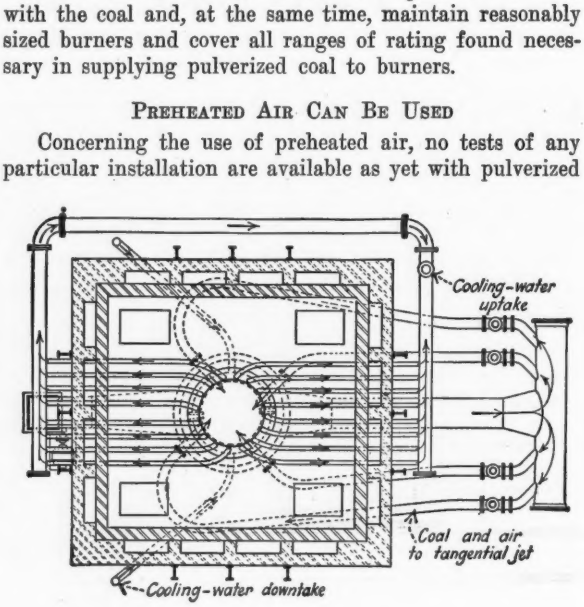
Design of the burner outlet is also of importance. A satisfactory construction is of the fish-tail type, about 18 or 20 in. long and 2 in. wide in the opening. Such a burner with the above air pressure and suitable quantity of primary and secondary air, running at the maximum given, would burn average bituminous coal with a flame length of about 10 ft., when fired horizontally. The above applies to the storage system where accurate and constant feed of coal can be maintained to the burners. For the unit system a different solution of burners is involved, as much more coal must be delivered with larger burners, on account of unequal distribution.

Best practice today, in regard to primary air, as has been successfully demonstrated in more than two hundred installations over a period of several years, is to supply about 30 per cent of the total amount required for complete combustion delivered with the coal and to supply the balance by induction, partly through supplementary doors at the burner and partly through other openings suitably located in the furnace walls.

Thirty per cent of primary air has been found to be about the maximum amount that it is possible to admit with the coal and, at the same time, maintain reasonably sized burners and cover all ranges of rating found necessary in supplying pulverized coal to burners.

PREHEATED AIR CAN BE USED

Concerning the use of preheated air, no tests of any particular installation are available as yet with pulverized



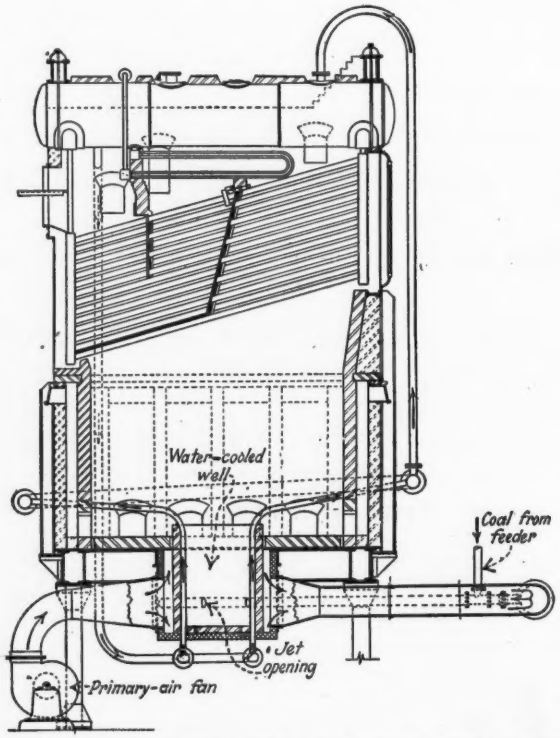


FIG. 3. BOILER SETTING WITH WELL-TYPE FURNACE FOR POWDERED COAL

coal. Several plants are about being started wherein data can later be obtained. In general, the application of preheated air at fairly high temperatures can be taken care of to good advantage with pulverized coal without detriment to the boiler settings or the fan and piping equipment delivering the air at high temperatures.

Certain types of mills are suitable for handling high

temperature preheated air in the pulverizing process and passing this heated air out with the coal direct to the boiler furnaces. Such an unique installation is in operation at the Queensboro Gas and Electric Co., Far Rockaway, New York. This consists of three 36-in. special type air mills operating two 600-hp. boilers, using bituminous coal. One mill is a standby. The air has been heated as high as 200 deg. F., having first been passed around the ash-hoppers, of which there are two per boiler, and the burning results have been quite good. A rough check on this installation shows that approximately 50

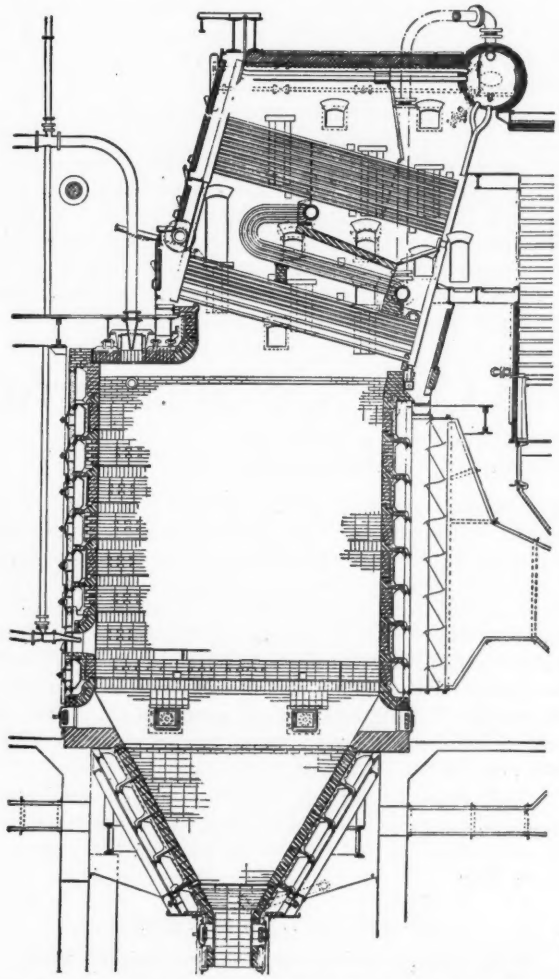


FIG. 4. SETTING FOR PULVERIZED FUEL IN THE COLUMBIA POWER STATION NEAR CINCINNATI

per cent of the theoretical amount of air required for combustion enters the furnace with the coal through the burners. This installation is practically a unit system, but totally different from the usual type and has great possibilities.

Preheated air involves considerable additional expense in first cost. Whether the fixed charges can be more than recovered will have to be determined in each individual installation. Claims made in regard to per cent of saving are of such wide variation—between 1½ and 8 per cent—that it is difficult to determine accurately what the net results will be with a given preheated air temperature. This can be calculated theoretically but, as above stated, the writer knows of no tests having been made wherein a definite conclusion has been reached. There will be a good opportunity for considerable research work in this direction when the plants above referred to are in running order.

Power Required for Pulverizing and Handling

Power required to operate a completely equipped pulverized-coal fired boiler plant on the storage system, including all auxiliaries within the pulverizing department and including transport system, drying, primary air supply and feeding coal to the burners, should not exceed 17 to 18 kw-hr. per net ton of average bituminous coal prepared and burned, in any installation of capacity from 150 tons upward per day. If the plant operation requires a greater power consumption than this, something is radically wrong with the installed equipment and investigation will show that the pulverizers or auxiliary apparatus are inefficient. This statement will apply equally well to unit type installations.

This power in kw-hr. per net ton of coal is divided approximately as follows: Pulverizing mills, 12½; drying and cyclone, 1; transporting, 1¾; preliminary crushing, conveyors, elevator, primary air and feeders, 2¾. Total, 18 kw-hr. per net ton of coal.

Radical departure from the usual furnace design for high boiler ratings has recently been brought to the attention of engineers by a pioneer firm prominent in the pulverized coal business. This is known as the "Well Type" furnace, and after 3 yr. of study and testing is now being offered commercially.

It is claimed that the use of this furnace will permit the following: (a) Boiler furnace proper reduced one-third to one-half the height of present standard practice; (b) boiler house height reduced proportionately; (c) cost of both of the above reduced materially; (d) even higher boiler ratings than are available at the present time.

Several of these furnaces will shortly be in operation and particulars of construction and operation will then be available. A typical arrangement of this furnace and boiler combination is shown in Fig. 3.

Transportation Is Simple

Transporting of pulverized coal in pipe lines of nominally small diameter has been so highly perfected that it is almost as simple a matter today as is fuel oil transportation, up to distances of a mile and perhaps beyond, at the same time elevating the coal 125 ft. or much more, if necessary. So perfectly has every detail of operation been worked out that the control of delivery to any number of distant storage tanks is entirely in the hands of the operator in the pulverizing department. Included in the arrangement is a simple method of weigh bins whereby every pound of coal delivered to any storage bin is accounted for. The operator is also informed, by means of a signal light on the control board, when the distant bin to which the coal is being delivered is full. On account of the simplicity of the equipment involved and the comparatively low amount of air, as to both quantity and pressure, the power consumption per net ton of coal handled averages only about 1 kw-hr. No additional labor is involved.

One illustration of what has been accomplished by this system of distribution will suffice. At the Clark

Thread Co., Newark, New Jersey, pulverized coal equipment was installed nearly 2 yr. ago, to serve ten boilers, each boiler being supplied with a 10-t. storage bin. These bins are filled from the pulverizing plant, located nearly 1000 ft. distant from the boiler room, by a 5-in. pipe line which runs underground across a busy street, under the cotton mill, is then elevated about 60 ft. to the top of the boiler bins and tapped or valved off to each bin.

Air pressure in the pipe line just beyond the discharge end of the pump is only 10 lb. and about 8 to 10 cu. ft. of free air per cubic foot (35 lb.) of coal is used.

In closing, reference should be made to the latest large public service station which is just now being placed in commission. This is the Columbia Power Station of the Union Gas & Electric Co. (Columbia Gas and Electric Co. subsidiary) located about 20 mi. from Cincinnati, Ohio. Messrs. Sargent and Lundy of Chicago, Ill., are the engineers and, cooperating with C. W. De Forrest, Vice President and Chief Engineer of the Cincinnati company, have developed a most interesting and unusual power plant in which nothing has been omitted that would help toward reducing the cost of producing a kilowatt-hour.

Capacity of the first section of this station is 80,000 kw. in two generating units of 40,000 kw. each. Steam at pressure of 550 lb. and 750 deg. F. total temperature will be used in the high-pressure end of each turbine and reduced thereby to about 128 lb., then returned to a reheating boiler which will bring the temperature back again to 750 deg. F. but will not change the steam pressure; thence it will pass through the second or low-pressure turbine, after which it will be condensed.

Pulverized coal will be used and this combination, with the above efficient turbine arrangement, is expected to give results that will set a new mark for coal used to develop a net kilowatt-hour, namely 1 lb. or less, using average bituminous coal.

Boilers are eight in number, 1500-hp. units (15,000 sq. ft. heating surface) of cross-drum type. They will be fired both vertically and horizontally, a method never before used.

The arrangement of furnace is clearly shown in Fig.

Pulverizing equipment is of the central and storage system, of sufficient capacity to prepare to proper fineness for best efficiency about 1500 t. of bituminous coal per day. Rotary, indirect-fired dryers will be used in combination with six screen mills of 8 t. capacity each per hour and one large mill of 20 t. capacity. The prepared coal, after weighing, will be delivered to the boiler bins by the above described distributing system.

Unit Systems for Powdered Coal Are Successful

Ability to Serve Small and Large Plants, Dependability and Ability to Use Any Fuel Are Factors. By W. C. Heckeroth*

IN THE application of the Unit System of handling and burning powdered coal in connection with power boilers in both the Industrial Plant and the Central Power Station the great success that has been met with has led to its rapid adoption in reconditioning old plants as well as in the design of new plants.

Just a few years ago the feeling quite generally expressed when discussing this subject with an engineer or plant manager, was about as follows: "Yes, we are interested in powdered coal and believe it has great possibilities but we understand John Smith is going to try it out under one of his boilers, so guess we'll wait and see how he makes out."

Now, this feeling has almost entirely disappeared and installations are scattered from Maine to Washington and from Canada to the Gulf of Mexico.

All Sizes Are Available

Review of the installations made to date by the Erie City Iron Works discloses the interesting fact that exactly 50 per cent of the number are in connection with existing boilers, representing 43.7 per cent of the total rated horsepower, while 56.3 per cent of the rated horsepower is in new boilers. These boilers range in size from 100 horsepower, 66-in. diameter by 16 ft. long return tubular fire-tube type, to 1300 horsepower water-tube type.

Unit pulverizers are made in sizes that will handle as little as 100 lb. of coal per hour and units that will pulverize up to 10,000 lb. per hour are now available.

The general thought has existed that the Unit System was applicable only to the small industrial plant. While it is true that this system has brought within the reach of practically every small plant, the many benefits and large savings resulting from powdered coal firing, it is equally true that the larger size units mentioned above make the Unit System available even in the case of large boilers. In some cases two pulverizers are used to fire one large boiler. This is particularly advantageous where the load fluctuates widely, permitting one pulverizer to be shut down entirely for light loads and using both only for peaks. This flexible arrangement has the additional advantage of safeguard against complete shut down in case of accident or breakdown of the pulverizer, to which any piece of moving machinery is subject.

They have the advantage that, should an accident of any kind occur, they are outside of the furnace, immediately accessible and can usually be back on the line in a short time.

Dependability Was Proved

One instance which comes to the writer's mind, as illustrating the reliability of unit pulverizers, is a greenhouse where vegetables are grown under glass. During the past two winters the safety of the entire crop has depended on the continuous operation of a 300-hp. return tubular boiler, operating at times well over 200 per cent rating and fired by one pulverizer. In addition to this boiler, there were three small hand fired boilers of approximately 125 hp. each. These were not used after the powdered coal boiler was installed except to help out in the most extreme cold weather and without the new boiler were inadequate to maintain a temperature in the greenhouse sufficiently high to prevent the loss of the crop. An addition of approximately 80 per cent of surface had been made to the greenhouse when the new boiler was installed. This will seem to the average reader like taking a desperate chance but demonstrates the reliability of unit pulverizers.

*Engineer, Erie City Iron Works, Erie, Pa.

In the above installation a feature of special interest is that the pulverizer is driven by a direct-connected, slow-speed turbine instead of a motor, as commonly used.

Best evidence of the satisfactory performance and economy resulting from the adoption of the Unit System of powdered coal equipment is the number of repeat installations being made. In almost every instance it is found possible to make a saving of from 50 cents to $1

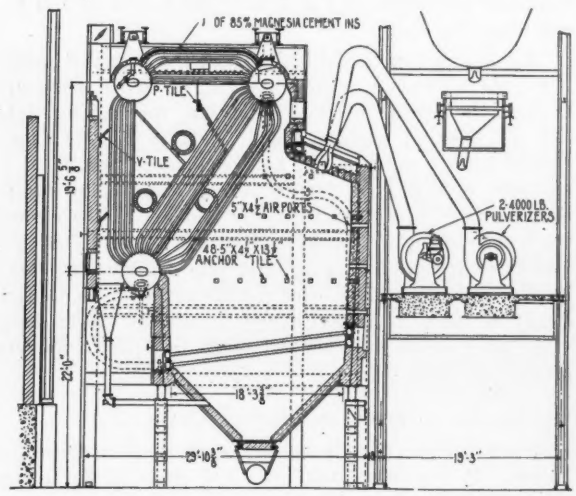


FIG. 1. EXCAVATION BELOW GROUND GAVE THE REQUIRED VOLUME FOR THE PULVERIZED FUEL FURNACE

per ton of coal, due to burning a grade of coal which though high in B. t. u., has characteristics which make it unfit for firing by other methods.

Suitable Furnace Volume Is Needed

It is quite generally known that to burn powdered coal properly and to safeguard the furnace linings it has, up

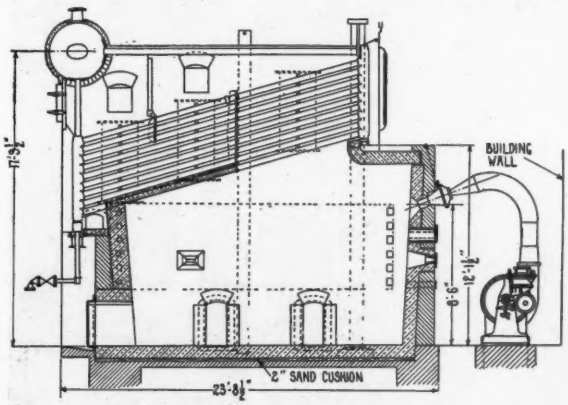


FIG. 2. SETTING FOR A 1300-HP. BOILER WITH UNIT SYSTEM FOR PULVERIZED FUEL

to the present time, been necessary to provide furnaces of considerably more volume than is required for other methods of burning coal. It should be remembered, however, that, when a change to powdered coal firing is made, it is usually with the purpose of also operating at higher ratings than ever before. This in part accounts for the larger furnace required.

In the case of existing boiler settings which are to be reconditioned and where available headroom will not permit of raising the boilers, it is sometimes found possible to utilize an existing basement by extending the furnace down to the basement floor level, or, where there is no basement, to excavate several feet below the existing floor level to provide a furnace of suitable proportions. Figure 1 illustrates an installation made under existing boilers by following the above mentioned plan. Figure 2 illustrates an installation for a new boiler of approximately 1300 hp. Figure 3 shows an installation of unit pulverizers in connection with vertical water-tube boilers.

Much attention has been given to the design of furnace walls and arches with the aim of obtaining the maximum life of refractories, absorbing the maximum percentage of heat units in the boiler and reaping the bene-

FIG. 3. TEN ERIE CITY UNIT PULVERIZERS FEEDING FIVE 557-HP. VERTICAL WATER-TUBE BOILERS

fits of operating at a high percentage of CO_2 with low excess air. The conditions to be met in each case govern the type of construction recommended. Where high overloads are not necessary or required, solid wall construction is sometimes used. In many cases hollow walls provided with air circulation, the heated air being used for combustion, are used. In extreme cases, where coals having ash which fuses or melts at very low temperature, are to be burned, the furnace walls are constructed of tubes, usually insulated with refractory tile. These tubes connect into headers which in turn are connected with the boiler proper so that, in effect, the furnace becomes part of and adds effective heating surface to the boiler.

Coal should be of a size that will pass a one and a half inch ring and be free of tramp iron. No dryers are required and, if coal bunkers and a crusher are already in use, the coal can be fed from the bunker to the pulverizer and from this direct to the furnace to be fired. Coal is pulverized only as used and is never stored in powdered form, thus eliminating any hazard. A plant operating on powdered coal has the advantage of being able to operate efficiently on coals ranging from the poorest quality to the very best, also on lignite containing from 25 to 35 per cent moisture or on petroleum coke where this is available.

Mechanical Stokers in Small Plants

Use Is Increasing and Results Show Satisfactory Returns. By R. L. Beers

WE HAVE been hearing considerable about the new developments and highly efficient results that are being obtained in the boiler rooms of the large central stations, and possibly have been losing sight of the progress that has been taking place in the small plants, that is plants under 1000 hp. in size and with boilers up to 300 hp. each. The small plant has also been making progress right along with its big brother. The requirements to corner the last B. t. u. and the operating organization have not been so elaborate but the relative gain in the final results in many of the small plants compares favorably with that in the large central stations. This is due not only to improved equipment but to a better knowledge of combustion by the operating engineers, to improved combustion equipment and to advanced plant design.

Small plants are here to stay. They will always be required for heating and, where it is necessary to have low-pressure steam for process work or for heating, it is difficult for the central power station to compete. The small plant usually has a less highly skilled organization for keeping continual check on operation, hence it is important that equipment be provided that will tend more or less automatically and continuously to give highly efficient results. Many engineers are realizing the importance of putting mechanical stokers under small boilers and are installing power-operated stokers under boilers of 100 hp. and larger in size.

For saving fuel in the boiler room the principal means is to obtain proper combustion. It is, of course, necessary to keep the setting in good condition, the baffling tight and the heating surface clean. This is usually taken care of but, in order to get best combustion results, it is necessary to have good furnace design and stoking equipment to feed in coal continuously and air in the correct ratio. The underfeed forced draft stoker accomplishes this. Gases are driven off at a uniform rate and complete combustion can be obtained over a wide range in load. Efficiency of hand firing most closely approaches stoker firing with low volatile and low ash coals and the difference greatly increases with the high volatile coals.

Types of Stokers Used

Several types of stokers are being used under small boilers. In the West, natural draft chain grate stokers

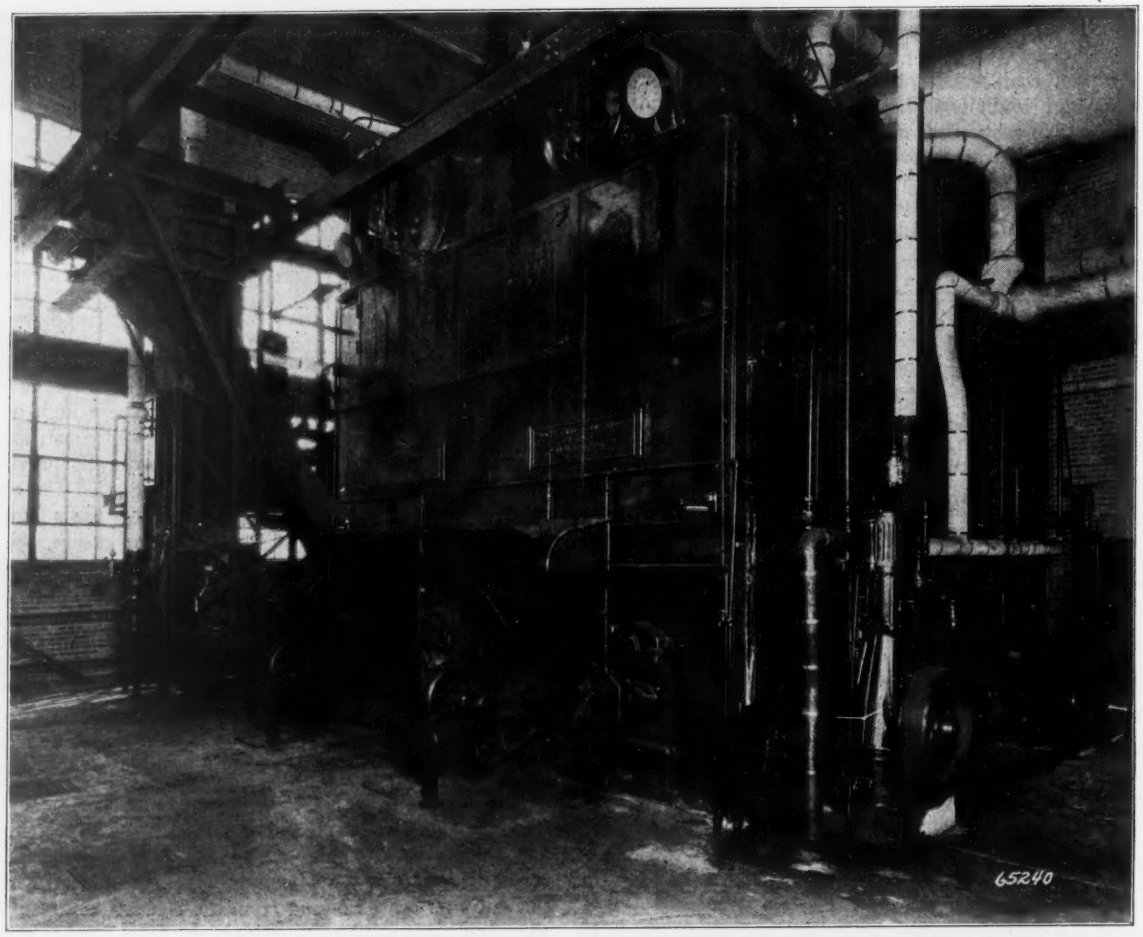


FIG. 1. SINGLE-RETORT STOKERS UNDER 150-HP. BOILERS WITH OVERHEAD BUNKERS AND WEIGHING LARRY

are installed in many installations. In the East V type natural draft and rear-cleaning inclined type overfeed stokers have been quite extensively used in the past. The general tendency, however, at the present, both in the East and West, is towards forced-draft underfeed stokers. This type of stoker, when properly installed, will, in the majority of installations, give greater flexibility, higher efficiency and burn a wider range of fuels than natural draft stokers.

Underfeed stokers are manufactured in two principal types,—side cleaning and rear cleaning. The side cleaning stoker is best adapted where it is desirable to remove ashes at the front of boiler. No space is required at the side of boiler, hence three can be installed in a battery. The rear cleaning type of stoker can be adapted to boilers over 200 hp. in size, particularly where heavy overloads are required. Space is required at the side of boiler for cleaning fires. The cost of stoker and installation is usually higher than for the side cleaning stoker. Underfeed stokers are driven directly by steam-operated pistons or by power through reduction gearing. The latter or mechanical-drive type of stoker can be operated by electric motor or by steam engine and is usually considered as being more economical than the steam actuated types.

Side-cleaning, forced-draft underfeed stokers are particularly well adapted to small boilers. They operate at high efficiency and can be installed at a nominal cost. No arches or elaborate brickwork are required for ignition and the stokers can be set directly under the boiler heating surface, utilizing to the fullest extent the radiant heat of the fuel bed. Green coal is kept at the bottom of the fuel bed, protecting the iron work and keeping maintenance at a minimum. The hot incandescent part of fuel bed is on top permitting of maximum heat transfer by radiation.

Stokers Have These Advantages

Following are some of the advantages of stoker firing: 1. Ability to burn cheaper grades of coal; 2. Higher efficiency; 3. Increased capacity; 4. Smokeless combustion; 5. Greater flexibility and more automatic operation; 6. Reduce labor turnover. Any of the above advantages may be sufficient to justify an installation.

Few plants are exactly alike and each one has its separate and distinct problems. The underfeed stoker gives best results with a nut, pea and slack size of coal that will pass through a 1½-in. screen. In most localities there is a surplus of screenings and it can be purchased usually from 50 cents to $3 per ton cheaper than lump or run of mine coal, which is used for hand firing. This saving alone in many small plants has made an excellent return on the stoker investment. Again some hand-fired plants in cities have been using certain smokeless fuels in order to avoid trouble with the Smoke Inspector. By changing to stokers they were able to eliminate smoke and use a fuel considerably cheaper in price without any sacrifice in evaporation.

Results from a number of plants which have been changed over from hand firing have shown an average saving in the amount of fuel varying between 10 and 40 per cent. Assuming a conservative net saving of 15 per cent for a plant burning 2000 t. of coal at $6 per ton and with a stoker investment of $3000, the saving would be $1800 or a return of over 60 per cent. Thus the installation would be paid for out of savings in amount of fuel alone in a little over a year. Many installations have paid for themselves in less than a year.

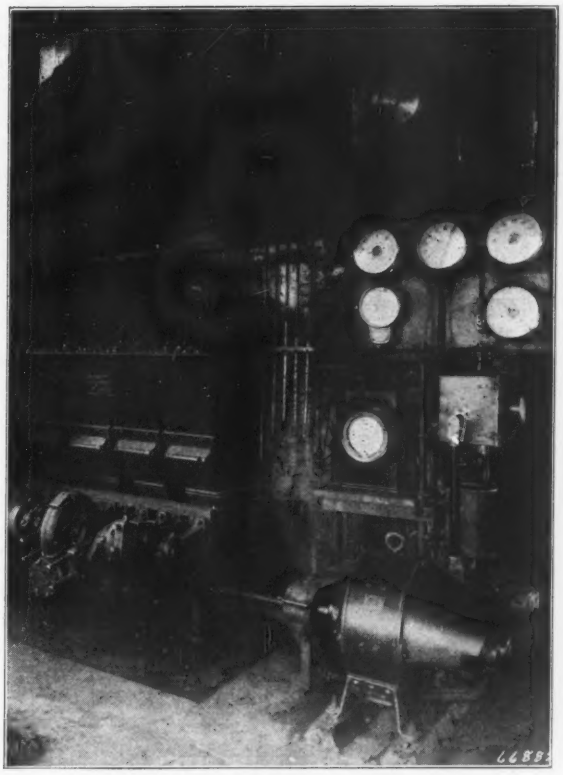


FIG. 2. ONE OF TWO 230-HP. BOILERS STOKER FIRED WITH FULL EQUIPMENT OF INSTRUMENTS FOR EFFICIENT OPERATION

With forced-draft stoker firing there is usually a considerable gain in the capacity of the boiler. The capacity may be increased from 25 to 100 per cent depending upon the size of stoker installed and capacity of the stack. In many instances, installations of stokers have not only saved installing additional boilers but have also saved expensive alterations to the building which would be required to provide space for the new boilers.

With hand firing it is difficult to prevent smoke which is the result of incomplete combustion. With stoker firing and the proper setting combustion is complete and there is no smoke provided the fuel bed is not disturbed.

Mechanical stokers are in most installations provided with automatic regulation which automatically varies the fan speed and coal supply from the steam pressure. This reduces the attention required by the operator and tends to give uniform steam pressure. By having forced draft, extreme flexibility is provided for taking care of wide fluctuations in load.

In small plants the stoker does not always reduce the number of operators, unless coal and ash handling equipment is provided, but it makes firing easier, more interesting and holds the services of a better grade of operator. This tends to reduce the labor turnover and, in the moderate sized plants, there is a decided saving in labor which alone may pay for a stoker installation in a few months.

Often the question arises as to how small a boiler should be equipped with a stoker. This depends upon the

conditions, particularly upon the amount of coal being burned. If only a small return could be realized on the investment, it probably would not pay to install a stoker. Stokers have been installed under boilers as small as 60 hp. where an excellent return has been made upon the investment. The conditions might be such that installation of a mechanical stoker would be justified to prevent smoke, to provide a steady heat, or to provide more automatic operation so that the fireman could attend to other duties.

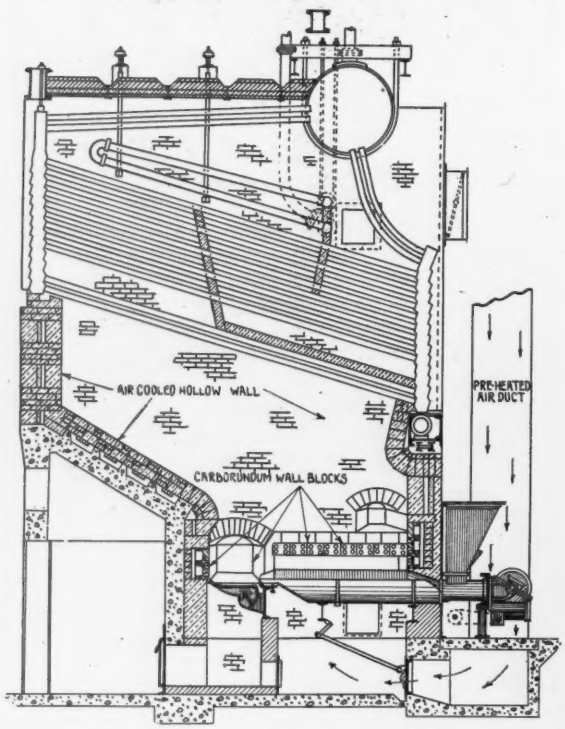


FIG. 3. EFFECTIVE SETTING FOR SMALL STOKER PLANTS

Typical Small Power Installations

Figure 1 illustrates a typical installation of side-cleaning underfeed stokers under two 150-hp. water-tube boilers. It will be noted that overhead bunkers are used with overhead coal weighing larry and the plant is kept in neat condition. Ordinarily, for this size plant, the coal is shoveled into the hopper from the boiler room floor.

Figure 2 is a small plant of the most modern and advanced design. The boilers are 230 hp. of the horizontal water-tube, cross-drum type and are operated continuously at 225 per cent of rating with Indiana coal. Steam pressure carried is 300 lb. with 150 deg. superheat and preheated air at 270 deg. is supplied for combustion. It will be noted that instruments are provided to indicate steam flow, boiler draft, etc., so that the maximum efficiency may be obtained at all times. The stokers are of the multiple retort rear cleaning type, ashes being removed under the rear end of boiler on the boiler room floor. Figure 3 shows a side elevation of the setting, which was especially designed for high rating and preheated air. The stokers are operated by slow-speed electric motors and the forced draft fan which is placed overhead adjacent to the air preheater is also operated by an electric motor.

Figure 4 shows an installation of the Double Retort type of side-cleaning stoker. This is a recent development in the stoker industry. It is really a multiple-retort stoker but adapted for side cleaning of the ashes. It has been particularly developed for boilers of 250 hp. and larger for heavy overloads where it is necessary to remove the ashes at the boiler front. Two retorts are used to feed in the coal which previously has been done by one.

Stokers, like all other mechanical equipment, require some attention and the more intelligent the operation the better will be the results. In order to obtain good results, the fireman should have necessary draft gages, flow meters and instruments which will aid him in obtaining best results at all times. Instruments should be selected which can be easily read and are rugged in construction, so that they will not readily get out of order; otherwise they will not be used long. Records of amount of coal and water should be kept, if possible. Weekly tabulation of coal weights for each shift should be posted with water evaporated, if available. This stimulates interest and gives the fireman a mark to work to.

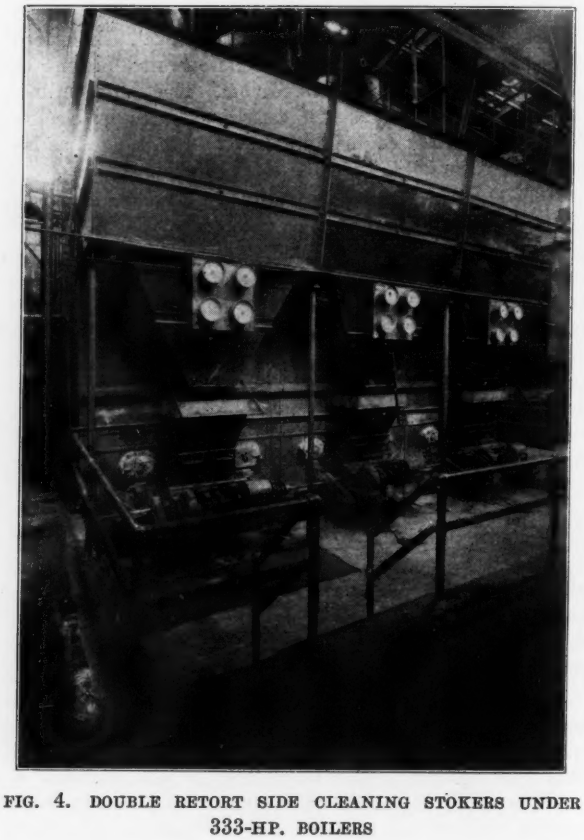


FIG. 4. DOUBLE RETORT SIDE CLEANING STOKERS UNDER 333-HP. BOILERS

Each plant has its own individual and distinct problems. Practically no two plants are alike. Each one requires special study in order to make the proper application of stokers. With the fund of information and experience available on furnace design and combustion, good results can be assured to meet practically all conditions. Hand fired plants are rapidly being equipped with mechanical stokers and indications are that practically all small plants will eventually be stoker fired except possibly those burning very small quantities of coal.

Automatic Control of Fuel and Air to Boilers

STEAM PRESSURE SHOWS RELATION OF INFLOW AND OUTFLOW OF B.T.U. AND CONTROLS REGULATE AMOUNT AND PROPORTIONS OF FUEL AND AIR FOR BALANCE. BY H. M. HAMMOND*

FOR PROPER operation of a steam boiler, taking for an example the pulverized coal fired installation operating on natural draft as shown diagrammatically in Fig. 1, it will be noted that there are two factors to be controlled for regulating the combustion process; namely, fuel and induced draft. To operate this boiler satisfactorily and efficiently these two basic controls must be guided by certain definite results. The first of these is steam pressure. To obtain the desired capacity, the steam pressure is a guide indicating the balance between the B.t.u. required by the turbine or other equipment and the input of B.t.u. brought about by the combustion of the fuel. In other words, the steam pressure is an indication of the relation between the inflow and outflow of B.t.u. to and from the boiler. When the steam pressure holds constant, it indicates an exact balance. When the steam pressure is dropping, it shows that the steam is carrying heat out of the

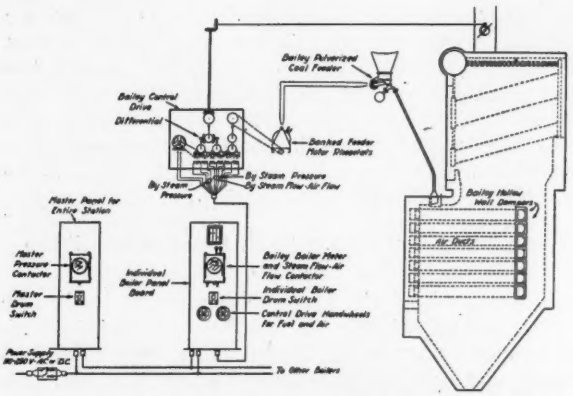

Bailey Pulverized Coal Feeder
Bailey Control Drive Differential
Damped Feeder Motor Rheostats
By Steam Pressure
By Steam Pressure
By Steam Flow-Air Flow
Master Panel for Entire Station
Bailey Hollow Wall Damper
Air Ducts
Master Pressure Contactor
Master Drum Switch
Individual Boiler Panel Board
Bailey Boiler Meter and Steam Flow-Air Flow Contactor
Individual Boiler Drum Switch
Control Drive Handwheels for Fuel and Air
To Other Boilers

FIG. 1. MASTER PRESSURE CONTACTOR CHANGES RATE OF FUEL AND AIR SUPPLY WHILE BOILER METER ADJUSTS THEIR RELATIONSHIP

boiler faster than the fuel is replenishing it, therefore a higher rate of combustion is called for. To supply this combustion from coal, or fuel in any form, air is required. In the case of a fuel bed, if the coal is already on the grate, then the supply of more air will be sufficient temporarily, but the burning away of the coal calls for a replenishment of the fuel in order that the desired fuel bed conditions may be maintained. A drop in steam pressure, therefore, calls for a simultaneous increase of both the fuel and air supply. In the case of stokers with fuel beds, the need for this exact synchronism of events is not so essential as it is in the case of pulverized fuel, gas and oil.

CONTROLLING RATIO OF AIR TO FUEL

Steam pressure can be maintained by the supply of fuel and air regardless of combustion efficiency or good heat absorption but the best combustion efficiency is only brought about when the fuel is completely burned with a minimum excess air, creating a high heat potential or high furnace temperature so as to get good and complete transfer of heat from the gases to the water in the boiler and economizer. The second problem of control, therefore, is to govern the relationship between the fuel and air in order to maintain this best combustion efficiency.

The necessity for changing the rate of supply of fuel and air to meet the varying demands for steam calls for variable speed control of pulverized coal feeders and mechanical stokers as well as of forced and induced draft fans. It also calls for the use of valves or dampers for control of the gas, oil and air supply. It may seem like a simple problem to calibrate each of these controls to determine just what result or what capacities of each will be

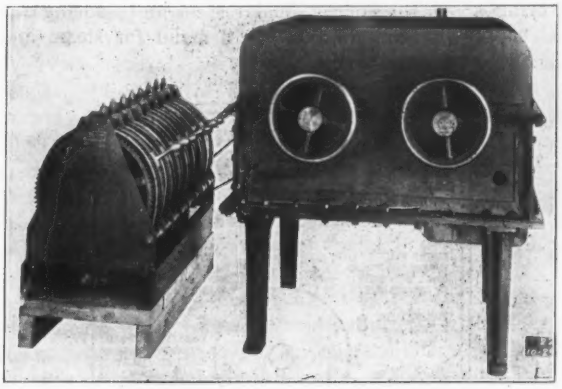


FIG. 2. THIS CONTROL DRIVE OPERATES FAN MOTOR RHEOSTATS, STOKER OR FEEDER CONTROLS, AND DAMPERS, AS REQUIRED

obtained over the full range of operation and then to determine the relationship of the position of one to the other. The same quantities, however, are not always delivered for the same position of a valve or damper, or for the same speed of a pulverized coal feeder, stoker or fan, so that the control system must often be called upon to readjust the relationship between these different factors if best results are to be obtained. These readjustments are necessary not because the load has changed but because the quantity of fuel or air delivered has not remained constant for a given position of the controlling device.

Air for combustion is supplied by means of a fan or stack so that the quantity can be easily controlled by opening or closing the damper or by changing the speed of the fan. It is impossible, however, to design a parallel system of control which will regulate the air in such a manner that the quantity of air being supplied will bear the correct relation to the quantity of fuel supplied, without readjustments. In the case of chimney draft regulated by a boiler damper, the amount of air supplied will vary, for a given position of the damper, with changing atmospheric and temperature conditions and with the condition of the boiler setting, which may affect the temperature at which the gases leave the boiler.

There are also many factors in connection with the supply of coal that tend to complicate the problem of maintaining a predetermined ratio between the fuel and air without continual readjustment. It would not be a difficult matter to establish a relation between pulverized coal feeder speed or stoker speed and quantity of air being

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supplied, but this will not insure the proper ratio of air to fuel. The height of coal in the bin, the percentage of moisture in the coal and other similar factors frequently cause a wide variation in the rate of pulverized coal feed for a given feeder speed. In the case of stoker fired boilers, if the hoppers are kept properly filled and there is nothing to interfere with the free flow of coal to the feeding mechanism, the volume of coal will bear a fairly close relation to the stoker speed. There are also variations in the quality of the coal and per cent of moisture in the fuel which make it impossible to maintain the correct ratio of air to fuel by simply establishing a definite relation between stoker speed and the weight of air supplied for combustion.

From the above it is noted that it is necessary to design the automatic combustion control equipment so that it will regulate each feeder, stoker, fan, damper or valve, so as to bring about the correct final results in balancing the fuel supply in proportion to the demand for steam and

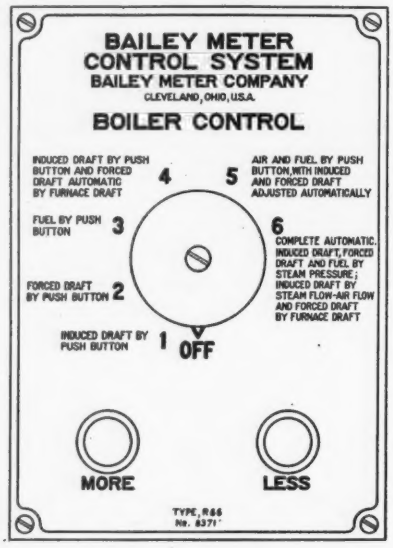
BAILEY METER
CONTROL SYSTEM
BAILEY METER COMPANY
CLEVELAND, OHIO, U.S.A.
BOILER CONTROL
INDUCED DRAFT BY PUSH BUTTON AND FORCED DRAFT AUTOMATIC BY FURNACE DRAFT
4
5
AIR AND FUEL BY PUSH BUTTON, WITH INDUCED AND FORCED DRAFT ADJUSTED AUTOMATICALLY
FUEL BY PUSH BUTTON
3
6
COMPLETE AUTOMATIC. INDUCED DRAFT, FORCED DRAFT AND FUEL BY STEAM PRESSURE; INDUCED DRAFT BY STEAM FLOW-AIR FLOW AND FORCED DRAFT BY FURNACE DRAFT
FORCED DRAFT BY PUSH BUTTON
2
INDUCED DRAFT BY PUSH BUTTON
1
OFF
MORE
LESS
TYPE, R66
No. 6371

FIG. 3. BOILER DRUM SWITCH ON EACH BOILER PERMITS INDIVIDUAL CONTROL

also to obtain the proper relation between fuel and air to maintain best combustion efficiency.

Excess Air Percentage Forms an Excellent Guide

Experience has shown that an excellent guide for combustion efficiency is to determine the percentage of excess air. The desired percentage of excess air for best combustion efficiency is that which will maintain the total losses due to excess air and unburned fuel at a minimum. Or, if the brick work is the essential factor, as it often is, one should maintain the lowest percentage of excess air and yet not encounter too great an expense in maintaining the brick work and furnace lining.

The relation of the steam flow from the boiler to the air flow used for combustion is a positive, instantaneous and accurate indication of the percentage of excess air and is well adapted as a guide for automatic control. This relation is basically correct because the rate of steam output from a boiler in reality represents the reading of a calorimeter showing the rate at which B.t.u. are developed in the furnace. The flow of air as indicated by the differential pressure across the boiler, taken at the proper points to eliminate chimney action, is a measure of the rate of air supplied to develop the B.t.u. Fortunately, the B.t.u. per pound of air used in combustion is substantially constant for all commercial fuels and the relation between steam flow and air flow is, in reality, a relation between the B.t.u. supplied to the furnace for burning the fuel and the desired percentage of excess air.

Controlling of Forced Draft By Furnace Draft

In case forced draft is used the third factor for controlling the combustion process is the furnace draft. It serves as an indication of a balance between the induced draft and the forced draft.

The system of control which must be carried out for best results is the same whether it is done by hand or automatic means. This involves the simultaneous changing of the rate of fuel and air supply to meet the demand for steam and then the readjusting of the induced draft fan to obtain the desired percentage of excess air and also the readjusting of the forced draft fan to maintain the proper furnace draft. If the induced and forced draft have both been changed simultaneous with the fuel they need to be only slightly readjusted, using the excess air and the furnace draft as guides in obtaining the correct final adjustment. A good fireman, with hand control, does this very thing and no system of automatic control will be successful unless it carries out the same procedure as a good man would follow with good controllable equipment available for accomplishing any desired result, as he observes the combustion and operating conditions.

Control of Pulverized Coal, Oil and Gas Fired Boilers

Some problems of control which come up in the case of fuels burned in suspension call for certain requirements as well as certain safety factors which are not required when using stokers. In the case of a pulverized coal fired boiler, for instance, there is an uncertainty as to just how much coal will be obtained for a given change in feeder speed and also how much the air may be increased for a given damper opening.

In most feeders the coal factor varies with the amount of coal in the bin, the percentage of moisture, etc., while the air for any given damper position will depend upon how many other boilers are on the stack, weather conditions, etc. It is obvious, therefore, that in order to make a safe increase in boiler rating the air should be supplied faster than the fuel in order that any deviations from the desired combustion efficiency will tend toward an excess of air which is always safe from smoke or other difficulties and later the air should be readjusted by hand or automatic means to suit the amount of fuel actually being fed to the furnace, as guided by excess air.

When decreasing the rate of steam output it is best to bring the air down more slowly than the fuel so as to tend again toward an excess of air and later to readjust the air down to the exact amount of fuel, as required for best combustion efficiency. A good fireman would naturally make these changes in the same order; that is, when increasing the rating, he would increase his air supply and then bring the fuel up. In decreasing the rating, he would decrease the fuel supply and then bring the air down. To accomplish this with automatic control requires a different speed of the control of either the fuel or the

air, or both, according to the direction in which it is going.

Application of the foregoing principles to automatic equipment designed to take account of the variations necessary in fuel and air supply has been made in the Bailey meter control. The basic principle of this control system is to change the rate of supply of both fuel and air simultaneously in acordance with the demand for steam as indicated by changes in the steam pressure from a suitable point in the main header. This is brought about by a master steam pressure contactor, similar to the one shown

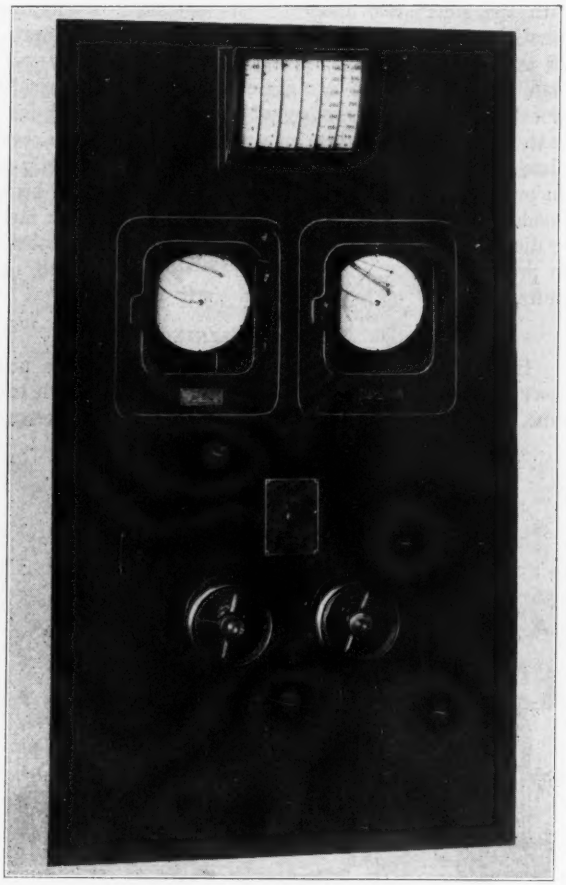

FIG. 4. INDIVIDUAL BOILER PANEL CARRIES METERING EQUIPMENT, BOILER DRUM SWITCH AND HANDWHEELS FOR MANUAL ADJUSTMENTS

in Fig. 1 mounted on the master panel board. The relationship between the fuel and air supplied to each individual boiler is continuously and automatically modified, so as to maintain best combustion efficiency, by the steam flow-air flow relation of the Bailey Boiler Meter which readjusts the air for each boiler in accordance with the fuel supply, in order to maintain the correct excess air at all ratings. In the case of boilers using forced draft, this system also maintains the desired furnace draft. This may be a true balanced draft or a furnace draft that increases slightly with the boiler rating.

The master control by steam pressure is applied to the supply of fuel and air to every boiler, so that each will take its share of the changes in load and will maintain a rating at all times substantially equal to that of each of the others. Any variations in the quality or rate of feeding of coal to an individual boiler call for a different air supply, which is automatically readjusted to suit the fuel requirements for the boiler in question and maintain it in a condition of best operating efficiency.

In the case of pulverized coal, oil or gas fired boilers the Bailey control drive shown in Fig. 2, which actually operates the fan motor rheostats or controllers and dampers in accordance with the electrical impulses sent out by the master pressure contactor, is so designed that for an increasing rating the air advances faster than the fuel and on a decreasing rating the air comes down more slowly than the fuel, thereby tending toward an excess of air at all times. As previously mentioned the relationship between the fuel and air supplied to each boiler is continuously modified automatically by the steam flow-air flow relation to maintain the correct excess air at all ratings.

These control drives have other important features relating to safety of operation that are essential when burning fuel in suspension. One of these features is that when the maximum capacity of the air supply is obtained, an interlock prevents any additional fuel being supplied. When the fuel supply is reduced to its lowest limit, another interlock likewise prevents the air from being further reduced. There are also travel limits to protect against overtravel of the controllers, dampers and the like.

In addition to a master drum switch on the master panel board which permits operating all boilers together by steam pressure or push button, each individual boiler has a boiler drum switch similar to the one shown in Fig. 3. This type of switch enables the operators to take any boiler off automatic control and to operate it by push button if desired.

Hand wheels directly connected through the control drive to the fuel and air supply are available for emergency hand control, in case of failure of current to the control system. Figure 2 shows one of the control drives connected to a bank of pulverized coal feeder motor rheostats and to an up-take damper, for control of the pulverized coal feed and air supply respectively. An individual boiler panel, showing the metering equipment, boiler drum switch and the handwheels of a Bailey control drive, is shown in Fig. 4.

ACCORDING TO a recent report to Secretary Hoover during the fiscal year ended June 30, 1925, the Bureau of Standards, Department of Commerce, completed 173,261 tests. This represents a considerable increase over previous years; 115,729 tests having been completed in 1923, and 135,852 in 1924. The fee value of the work is $547,543.35. This is also an increase over past years; the 1923 and 1924 figures being $419,915.70 and $509,850.87, respectively. All income so received is turned back into the Treasury of the United States, the expenses incurred in the tests being absorbed by the annual Congressional appropriations for the Bureau's maintenance.

Included among the great variety of materials and devices tested, were precision tapes, analytical weights, clocks, chemical glassware, electrical instruments and lamps, thermometers, sugar samples, radium, cement and concrete, fire resistant safes and roofing, aeronautic instruments, automobile tires, fusible boiler plugs, leather and paper. Almost every industry and branch of the Government has been served by the Bureau.

Development of High-Head Hydraulic Turbines

Changes Are Largely in Bearings, Details of Construction and Methods of Speed Control. By William M. White*

DURING the past 20 yr. many improvements have been made in the design of hydraulic turbines for high heads but the majority have been in the nature of minor refinements and simplifications and not radical changes, as is evidenced by comparing a recently constructed unit with the construction shown in Fig. 1, a 13,500-hp., 350-ft. head, 375-r.p.m. single-runner, vertical-shaft, cast-steel, spiral-cased turbine which was installed in the plant of the Great Northern Power Co. near Duluth in 1906. Figure 2 shows the power house which contains three of these units. It would require little imagination to see in this power house a modern up-to-date and recently constructed high head plant.

Few Changes in General Design

A brief description of the Great Northern Units will show where slight changes have been made. These units had cast-steel runners which were bolted to the flange of the main shaft. The steady bearing was of the babbitted, oil-lubricated type and the hydraulic thrust including the weight of runner, shaft and generator rotor was carried on the oil-pressure type thrust bearing, which was mounted on a bridge just above the turbine casing and below the generator rotor.

Thrust bearings are now usually mounted above the rotor and the Kingsbury type has superseded the old oil-pressure type. The water discharged through the curved draft tube which was lined with sections of cast iron. Guide vanes, of which there were 24, were of cast steel with the stems cast integral; the operating mechanism consisting of levers, links and shifting ring were all located on the cover plate as shown in Fig. 3 where they were readily accessible, the arrangement being almost exactly identical with the arrangement of any recent high-head unit. Two guide vane bearings were provided in the cover plate with an adjustable packing box between, exactly as on present day units. The shifting ring, instead of being inside of the guide-vane bolt circle was located on a larger diameter, which arrangement is not usually encountered in present practice, but is frequently used with small size units, especially of the horizontal shaft type.

Details of Governing

In order to guard against pressure rises in the penstock, two pressure regulators were provided for each turbine. More recent practice is to use only one pressure

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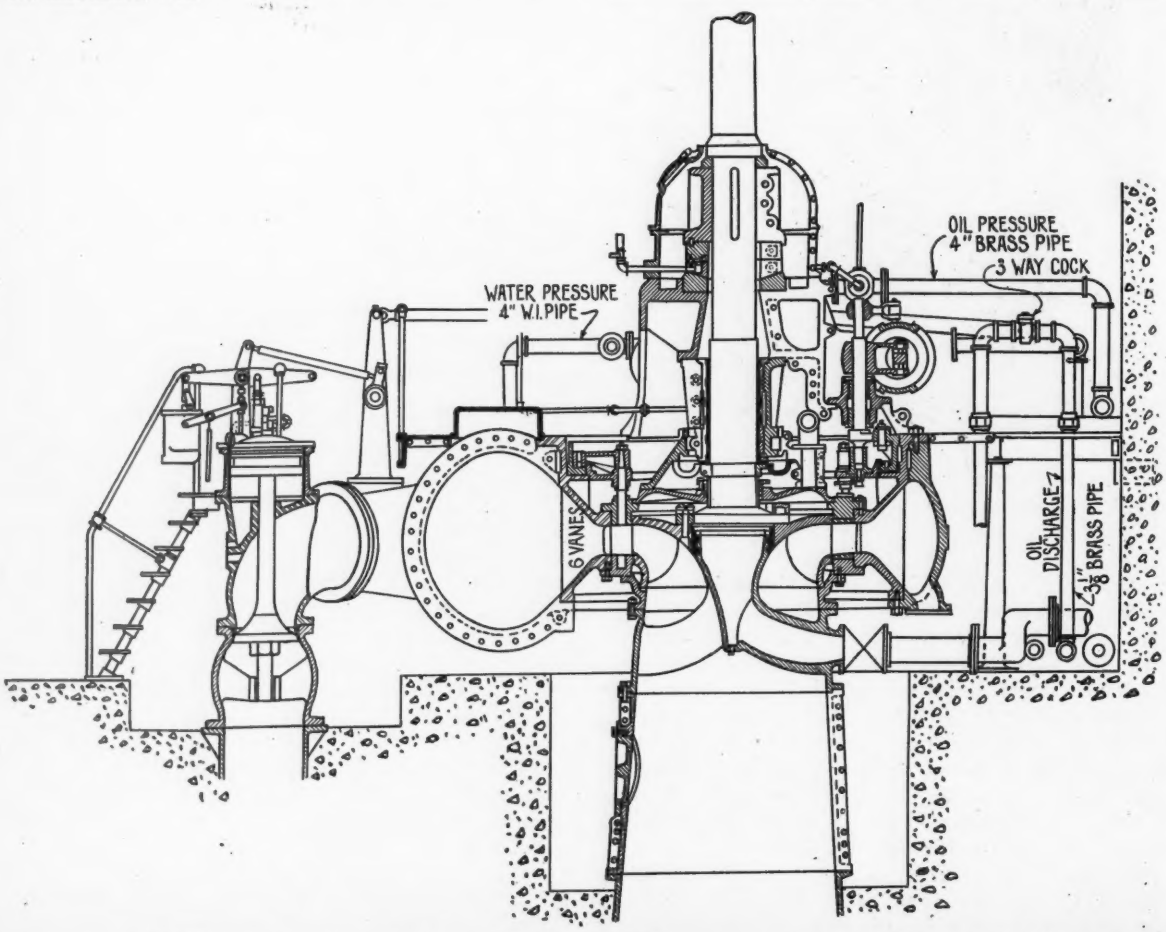

FIG. 1. THIS 13,500-HP. VERTICAL TURBINE FOR 375 R.P.M. AT 350 FT. HEAD, BUILT IN 1906 IS SIMILAR IN GENERAL DESIGN TO UNITS BUILT SINCE 1920

regulator of greater capacity, but the method of operation and the design of these pressure regulators were almost identical with that used at the present time.

The governor for the 15,000-hp. units, as shown on Fig. 4, has probably undergone the greatest number of changes, especially in external appearance, although the fundamentals of operation and design have seen few changes. Two regulating cylinders were provided but, instead of connecting directly to opposite sides of the shifting ring, each connected to a separate short regulating shaft which in turn connected to opposite sides of the shifting ring. Each one of these regulating cylinders consisted of two cylinders in line, each cylinder being single acting. The cylinders on the closing side were bronze lined for using water and were connected directly to the penstock so that penstock pressure always tended to close the turbine gates. The opening sides of the cylinders were connected to the oil pressure system, oil being pumped with three-cylinder reciprocating pumps, the main distributing valve being similar to those used at the present time.

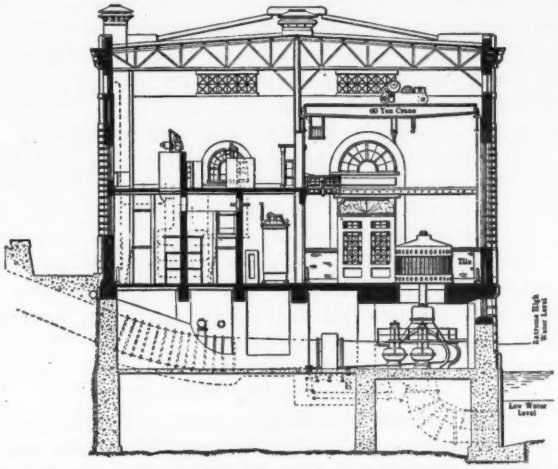

FIG. 2. DULUTH PLANT OF GREAT NORTHERN POWER CO. USED UNITS SHOWN IN FIG. 1.

This design of opposed cylinders with water pressure on the closing side provided an additional safety factor, so that, in case of failure of the governor oil pressure system, the gates would immediately be closed and runaway prevented since water pressure is always available.

Steel Casings Now Used

The spiral casing which had an inlet diameter of 64 in. was made of cast steel in two sections as shown in Fig. 3. The speed ring which contained 12 ribs, also of cast steel, was cast separately and belted to the casing flanges. More recent practice has been to cast the speed ring ribs integral with the casing but even as late as 1920, cast-steel casings for large size units were made with the separate speed ring similar to the Great Northern units. The valves used on the Great Northern turbine, located a short distance upstream of the casing inlet, were hydraulically-operated gate valves, 66-in. inside diameter, constructed of cast iron.

When we consider the seemingly great improvement in the art of hydraulic turbine design in the last 10 yr., it would seem that a unit of this capacity designed in 1906 must certainly be obsolete at the present time but such is not the case, as these units have been in practically continuous operation and no radical changes in the

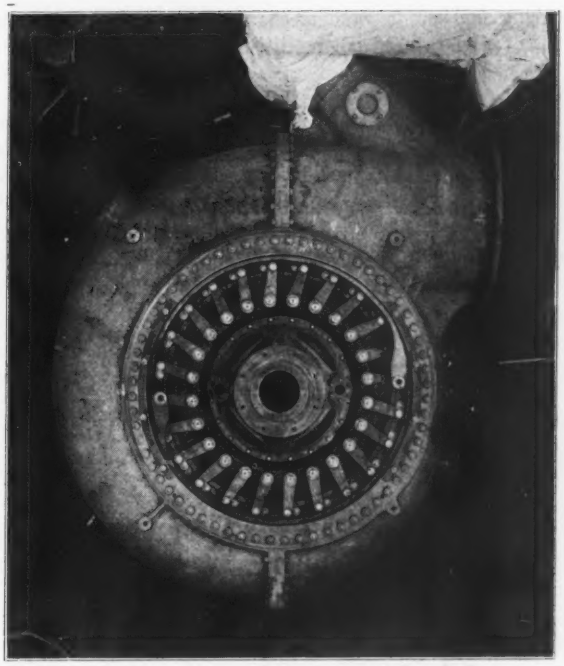

FIG. 3. THESE LINKS AND SHIFTING RING MOUNTED ON THE COVER PLATE CONTROL THE GUIDE VANES

essential parts of the turbine have been made until within the last 3 yr. when new runners of higher efficiency were installed and the original governors were replaced with the more recent design of governors, the motor-driven, gear-type oil pumps being substituted for the reciprocating plunger-type pumps.

Probably the recent trend of development in regard to high-head turbines can be more clearly covered by taking a recent example such as the 18,000-hp., 429-ft. head, 375-r.p.m. vertical units installed in the plant of the Keihin Denryoku Electric Power Co. of Japan, a section of the units being shown in Fig. 5. The general arrangement of the power house containing the two units with their direct-connected generators, is shown in Fig. 6.

Draft Tube Construction

Draft tubes of these units are of the curved concrete type, the elbow being almost square, as recent tests have shown this type to be much more efficient than the long-radius curved elbow. The concentric type, either with or without the cone in the center, would have resulted in slightly higher efficiency with quieter operation and less tendency to draft tube disturbances, although on a high-head unit of this type, the percentage of energy remaining in the discharge from the runner is slight and the relative gain by the use of the concentric tube is comparatively slight. The concentric tube has shown the greatest improvement in efficiency in connection with the lower head type of units where the amount of energy to be regained is relatively much greater.

Draft tubes on the Keihin units have the upper part of the telescopic type where the cast-iron barrel is bolted to the discharge ring of the turbine but so arranged that it may be lowered into the concrete portion of the tube, thus leaving a clear space some 5 or 6 ft. high, which permits of lowering the runner and other parts of the turbine for dismantling from below, so that the steady

bearing and guide vane mechanism which is located on the cover plate need not be disturbed.

Steel Runners Replace Cast Iron

Runner of the Keihin turbine is of cast steel, cast in one piece and arranged to be pressed onto the taper fit on the main shaft, where it is keyed and locked in place with a split stop ring, which fits into the annular groove of the shaft, just below the runner and prevents any axial movement along the shaft. The arrangement similar to the Great Northern units, where the runner is bolted to

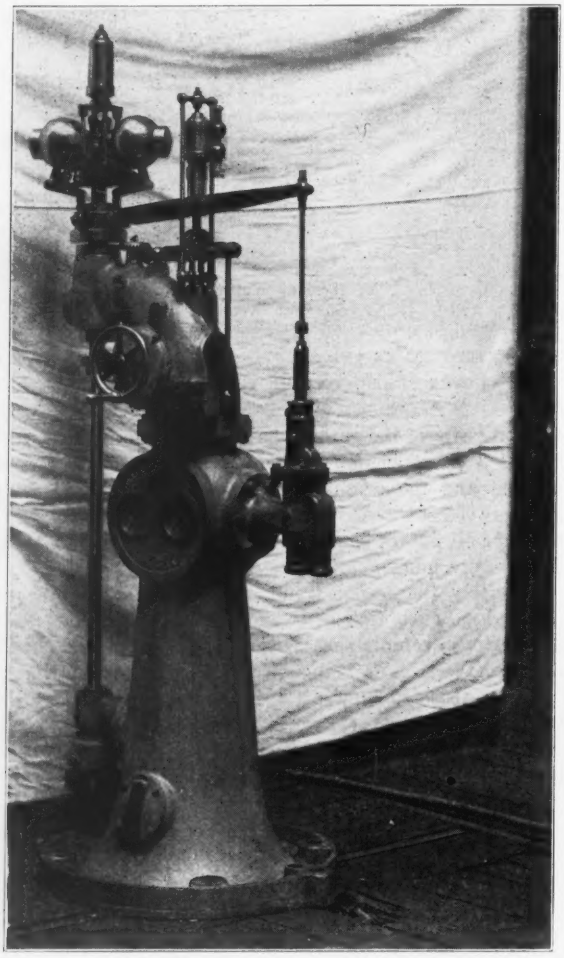

FIG. 4. THIS GOVERNOR CONTROL STAND WAS USED ON THE DULUTH TURBINES

the forged flange on the main shaft, is also used extensively at the present time. This is shown in Fig. 7, the runner being held to the shaft flange with ten or twelve fitted bolts, which are slightly tapered, with the holes in both runner and shaft flange reamed together to insure an absolute fit. The bolted arrangement is more easily disconnected in case it is desired to change the runners, as the pressed taper fit frequently requires special jacks in order to loosen the runner from the shaft, whereas with the individual bolts each bolt can be easily removed, thus leaving the runner entirely free.

Renewable steel wearing rings are provided at the runner clearances to form a labyrinth seal. On high-head turbines the amount of leakage around the runner clearances may amount to a large percentage, hence any method of reducing this leakage, such as the labyrinth seals, results in an appreciable increase in efficiency. It is estimated that each stage of the labyrinth seal decreases the leakage approximately 50 per cent so that the pressure drop per seal is decreased to such an extent that the life of the wearing rings is greatly prolonged.

Turbines shown in Figs. 5 and 7 are both provided with a renewable liner in the upper section of the draft tube, just below the runner, as the rapidly whirling water discharged from the runner may result in some pitting in this section. The faces of the cover plate and guide vane ring just above and below the guide vane openings are lined with renewable steel wearing plates, so that any wear on these parts can be taken care of without requiring entirely new parts. When a unit of the high-head type is shut down but water pressure is left in the spiral casing, the water leaking through between the ends of the guide vanes and the faces of the cover plate or guide vane ring tends to cause erosion, especially if there is some grit or sand in the water. This action does not take place when the unit is in operation, because then there is little drop in pressure between opposite sides of the guide vanes but units which are shut down for long periods are subject to this wear which increases rapidly as higher heads are encountered.

An interesting development in the design of the guide vane is the disc construction where two discs, one at each end of the guide vane proper, are cast integral with the guide vane and the cover plate and guide vane ring are so machined that these discs are recessed into the stationary parts, so that there is no clearance space between the end of the guide vane and the stationary part through which water can leak.

Wood vs. Babbitt Bearings

For the unit shown in Fig. 5, the main turbine steady bearing is of the water-lubricated, lignum vitae type, water being drawn from the penstock or the spiral casing and, after passing through strainers, admitted to the upper part of the bearing, keeping it flooded at all times. Also a small supply of grease is forced in, either with the water or separately, so as to assist the lubrication and provide an additional factor of safety in case the supply of water should fail for a short period. The main shaft where it passes through the steady bearing is covered with a steel sleeve so that, in case of wear, the sleeve may be replaced without requiring the entire shaft to be removed and remachined. Steel has been found to be decidedly better than the bronze sleeve, as there is a tendency for the bronze to rub or roughen, especially in case the bearing goes dry for a brief interval. This roughening does not occur with a steel sleeve.

Recent practice has been to make the lignum vitae bearings adjustable. In a lignum vitae bearing, strips of the wood approximately 2 in. square are wedged into dovetail grooves cast into the bearing housing, these grooves running axially with the shaft. When penstock water is used, it frequently carries considerable sand or silt which eventually causes wear of the lignum vitae block and, when the bearing is not adjustable, either an entirely new bearing must be substituted or the old bearing must be taken out, relined with lignum vitae strips and then rebored and fitted to the shaft, which may cause a shutdown for a considerable time. With the adjustable bearing, four

or six cast-iron shoes are set into the bearing housing, the shoes either being tapered at the back so that they may be slid farther down into the housing to provide adjustment, or made so that shims may be inserted behind the shoes to move them in closer toward the shaft. The surface of the shoes next to the shaft is provided with dove-tail

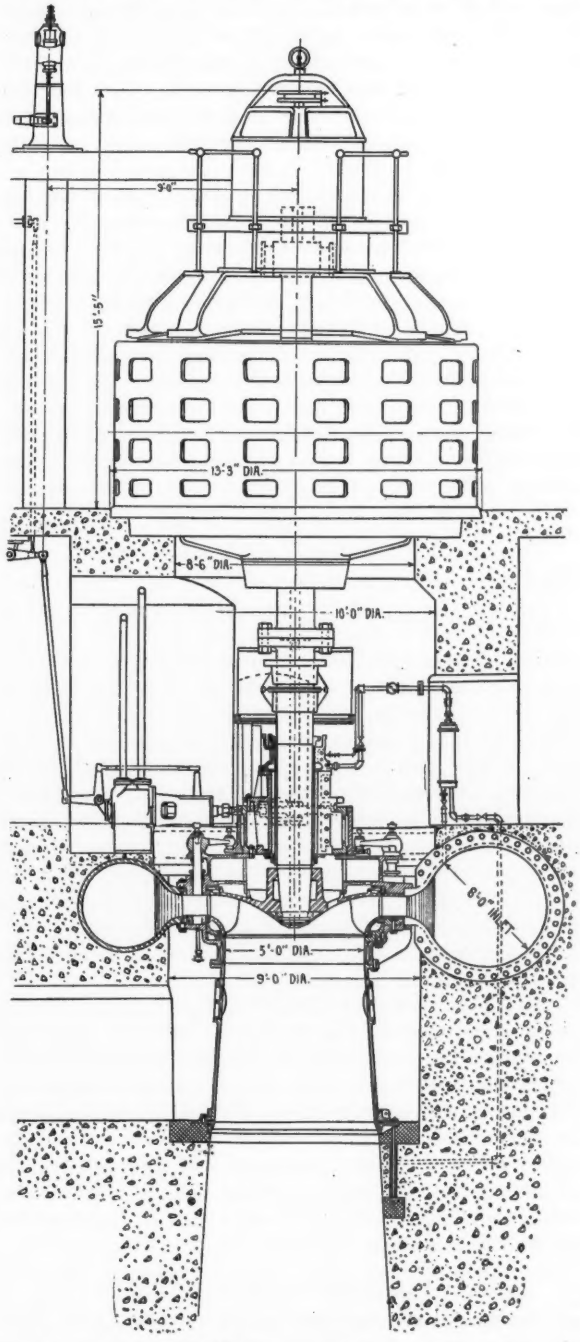

FIG. 5. RECENT 18,000-HP. TURBINE FOR 375 R.P.M. AT 429-FT. HEAD

slots in which the lignum vitae strips are wedged. This latter design of bearing has been used successfully on many large and medium size turbines for both high and medium heads, as well as on a large number of units for very low heads. Many engineers prefer the water-lubricated bearing on account of its simplicity but, where there is trouble with frazil ice, or considerable sand in the water, the oil-lubricated babbitted type of bearing is preferable.

In Fig. 7 is shown the main steady bearing of the oil-lubricated babbitted type similar to the design used on the steady bearings of large vertical shaft generators. The babbitt is held in a cast-iron bearing shell which rests in a seat in the cover plate extension. An oil reservoir is provided in the cover plate with a self-contained pump either of the gear type or viscosity type, which lifts the

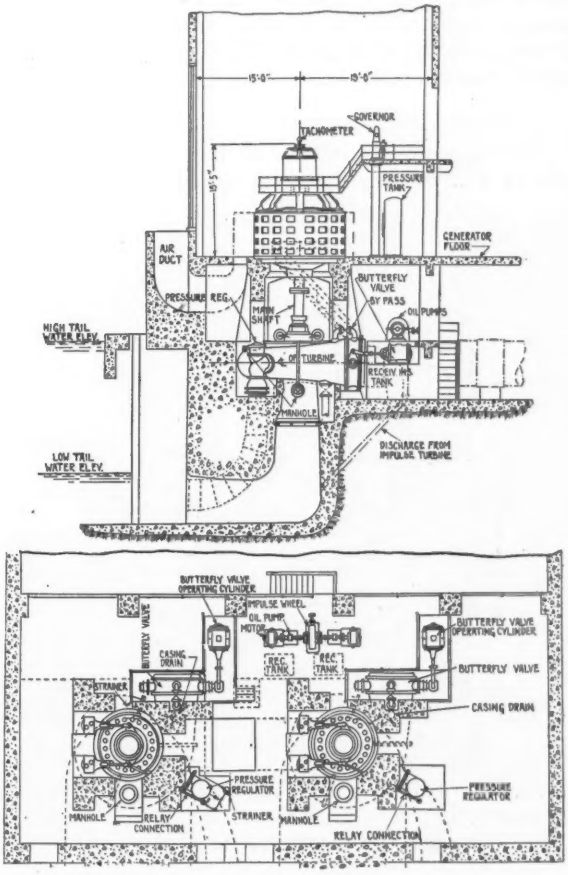

FIG. 6. KEIHIN ELECTRIC POWER CO.'S PLANT, USING THE TURBINES OF FIG. 5

oil to the top of the bearing whence it returns by gravity down through the bearing.

Casings Are Sealed by Packing Rings

Since there is a considerable vacuum on the lower side of the cover plate adjacent to the runner, a substantial type of packing box or sealing device must be provided. In order to keep the steady bearing as close as possible to the runner to decrease the overhang, it is not considered feasible to allow space above this packing to permit of inspection and adjustment and, therefore, some permanent sealing device must be installed which will not be subject to wear and which will not require attention over long periods of operation. The design of seal shown in Fig. 7 consists of four babbitted rings which fit closely around the shaft with drain spaces between each series of rings. The lowest drain space is fitted with lignum vitae ring consisting of blocks which are clamped around the shaft and held close to the shaft

by tension springs. Some grease or oil must be supplied to this type of seal for lubricant but this grease must be soluble in water, so as not to clog up the drain passages and prevent the free discharge of any water which may leak up along the seal.

Some engineers are of the opinion that oil-lubricated steady bearings are not practicable for vertical-shaft hydraulic turbines but such is not the case, as the oil lubricated bearings of the Great Northern units have been in operation since 1906. Self-contained bearings similar to that shown in Fig. 7 have been in operation since 1914, without any appreciable loss of oil and without dilution of the oil such as would be caused, if water leaked up and entered the oil reservoir.

Lubrication and Cooling Must Be Provided

Former practice with the oil-lubricated steady bearings as well as with the generator oil-lubricated steady

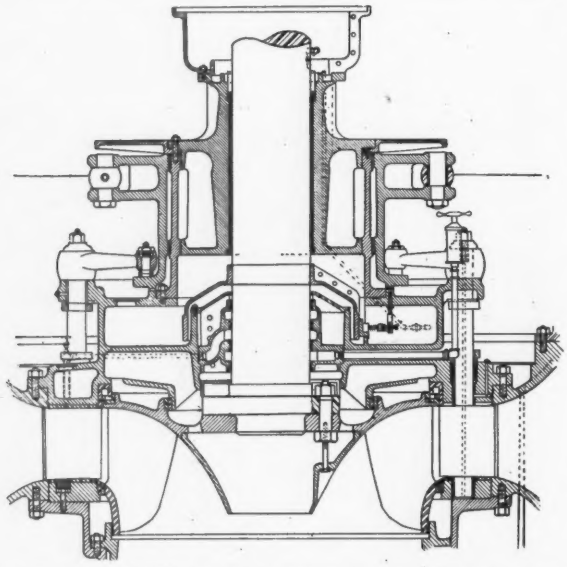

FIG. 7. THIS 19,500-HP. UNIT FOR THE DAVIS BRIDGE PLANT OF THE N. E. POWER CO. HAS RUNNER BOLTED TO SHAFT FLANGE AND LABYRINTH RUNNER SEALS

and thrust bearings has been to provide a central oiling system probably with the gravity tank located in some high part of the power house and pumping units and filters in the basement so that the oil is continually filtered and pumped. Such a system with long runs of piping, large filter tanks and separate pumps requires additional attendance and a greatly increased number of parts, offering additional possibilities for trouble. The most approved design at the present time is that with the least number of parts. The majority of oil-lubricated bearings at the present time have their complete self-contained lubricating systems, with no external circulation of oil or filter for the oil, since, if the bearing is entirely closed, a filter is not required, as no foreign material can enter it.

Large capacity thrust bearings where there is considerable amount of heat to be carried away are provided with cooling coils in the oil reservoir rather than circulating the oil through external cooling tanks. A recent method has been devised to do away entirely with the use of water for cooling this oil, by installing a series of cooling coils around the generator stator so that the ventilating air through the generator will cool these coils, the oil being allowed to circulate through these coils by thermo-syphon action.

Several types of pumps are in use for circulating the oil in self-contained bearings of the vertical shaft type. One method is to install a gear-driven pump in the oil reservoir, either above or below the bearing, this pump being driven by a gear clamped around the main shaft itself. A second is the viscosity type pump which uses the Kingsbury principle and has a shoe which presses against a revolving surface clamped to the main shaft. Such a device is shown in Fig. 7.

Another type of oiling device for this type of bearing is the spring oiler, where a small flexible spring is passed around the main shaft above the bearing and over pulleys and then dips down into the oil reservoir. A continuous supply of oil is brought up with the spring, which is caused to revolve by friction where it passes around the shaft. Frequently some other auxiliary form of pump is provided with bearings of this type, one form of which is a small motor-driven pump located above the bearing, the motor being equipped with an automatic float switch which will cause it to operate when the shaft-driven pump fails to bring a supply of oil to the top of the bearing.

Governors Should Prevent Penstock Shock

Governors on high-head Francis type turbines do not differ materially from those used with medium or low-head turbines, although they must be designed with greater care on account of the long penstock conditions with resulting pressure variations which usually occur with high-head plants. While it is possible to vary the time of stroke of practically any modern hydraulic turbine governor, the type of gate mechanism used with the Francis type turbine does not always result in a straight line variation between the position of the gates, quantity of water and the governor stroke, as a considerably larger quantity of water may be used from 3/10 to 4/10 gate opening, than from 8/10 to 9/10 gate opening, due to the characteristics of the guide vanes and the characteristics of the particular runner used on the unit. Such a variation in the rate of discharge may cause a serious pressure change in the penstock.

In order to overcome this condition, a method has been devised whereby the rate of travel of the gates may be regulated for any part of the gate movement so as to maintain practically equal rates of velocity change over any part of the governor travel. This device is also useful in connection with some pressure regulators whose discharge is not a straight line function of their position. It is also useful with impulse wheels equipped with needle nozzles where the discharge is not a straight line function of the position of the needle.

Valves Are Needed at the Turbine Inlet

Practically all high-head turbines require some form of valve at the inlet of the spiral casing as usually a high-head plant requires a long penstock and it is desirable to be able to shut off the water at the inlet of the turbine without requiring the draining of the penstock, for draining and filling the penstock takes considerable time and, in case of emergency, this time element might cause considerable damage to the machinery or to the plant. Valves for high-head units are of three types:

gate valves, butterfly valves and needle valves. The preference in practically all the recent high-head Francis type units has been for the butterfly valve.

At the time of installation of the Great Northern units in 1906, butterfly valves had not come into use. The needle-type valve had not been invented at that time, so that practically the only type of reliable valve suitable for this head was the gate valve. Gate valves are extensively used at the present time for heads above 1000 ft. such as are encountered with large, impulse-wheel plants and the majority of these high-head gate valves are hydraulically operated as this has proved the most simple and reliable method, although it is considerably more expensive than motor operation.

On account of its simplicity and ruggedness and because it offers such little obstruction to the flow of water, the butterfly type of valve has become popular during the last 8 or 10 yr. and has been used successfully up to heads of 850 ft. but it is not believed that it will be practical for heads above 1000 ft. Improvements in the butterfly valve such as sealing rings around the periphery of the disc have made these valves almost perfectly tight. Sometimes these sealing rings are made of bronze in the form of snap rings and recently a rubber sealing ring has been designed, offering good possibilities on account of its flexibility, which enables it to conform closely to the shape of the housing. Butterfly valves may be either motor or hydraulically operated. Both types of mechanism are giving satisfaction, the hydraulically-operated device being considered somewhat more reliable but also expensive.

Changes in Impulse Wheels

Discussion of improvement in high-head hydraulic plants would not be complete without giving some consideration to the design and construction of impulse wheels. Like the Francis-type turbines, no radical changes have been made in the construction of impulse wheels since early in 1900. The many and varied improvements have been in the nature of simplification of details in order to eliminate possibility of shutdown because of failure of minor auxiliary apparatus.

Units rated 10,750-hp. under 865-ft. head at 250-r.p.m., built in 1906 for the Kern River Station of the Edison Electric Co., which is now owned by the Southern California Edison Co. and which have been in practically continuous operation since the time of its construction, are of the double overhung type, with a disc and buckets overhung from each end of the generator shaft. The generator is located between the two ring-oiled pedestal bearings which carry the entire revolving weight. It is apparent that radical changes have not taken place in the general arrangement or design of impulse turbines as this arrangement is used almost entirely in modern practice.

Housings on these impulse wheels were of cast iron, while present practice tends to plate steel housing because of the greater tensile strength of the plates. In case a bucket or bolt should come loose from the impulse wheel, traveling as it does at a high rate of speed, the cast-iron housing would offer little resistance and considerable damage might be done in the power house, whereas the plate-steel housing will offer much greater resistance and, in all probability, will not allow an object to pass through it.

Kern River units are equipped with hand-operated needles but the nozzle, which is governor operated, is arranged so that it deflects and the jet is lowered so as to shoot free from the buckets. While this arrangement worked out very efficiently and eliminated the necessity for a separate pressure regulator or relief nozzle, the high-pressure packing boxes at the rotating joint in the nozzle pipe required frequent attention to keep tight, therefore this construction has practically been discontinued.

In the Kern River Station the gate valves were hand and motor operated. They were of the rising stem type and were not equipped with slot-filling follower rings, so

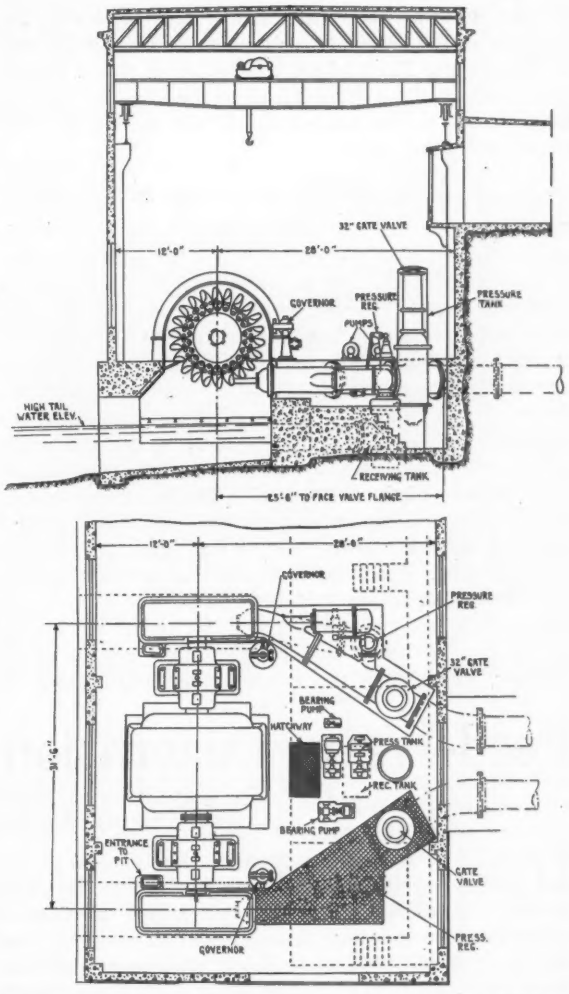

FIG. 8. THIS IMPULSE WHEEL, 40,000 HP. FOR 2312-FT. HEAD AT 360 R.P.M. WILL BE INSTALLED AT THE KERN RIVER PLANT OF THE SAN JOAQUIN (CALIF.) LT. & POWER CO.

that the interior of the gate valve, when in the open position, offered a decided break to the smooth flow of the water through it. Recent practice is to equip the valve with a projection which, when the valve is in the full open position, fills the slot left by the gate valve plug and the inside of the valve offers a smooth and uniform passage. This construction requires an extension below the valve equal to the diameter of the penstock itself but the resulting smoother flow of the water effects a gain in efficiency which more than compensates for the additional cost.

For comparison with the Kern River units built in 1906, Fig. 8 shows the plan view and elevation of a double overhung unit now under course of construction for the Kings River plant of the San Joaquin Light & Power Co., this unit being rated 40,000-hp., at 2312-ft. head and 360 r.p.m. The static head on this plant will, at times, exceed 2450 ft. The unit consists of two 20,000-hp. wheels, each wheel being overhung from the extended end of the generator shaft. The generator rotor and the two impulse wheels are carried on two ring-oiled pedestal bearings, one being located on each side of the generator. Housings on these units will be constructed of plate steel with the exception of the lower part or foundation ring, which will be of cast iron. Each bucket will be bolted to the forged-steel disc with three fitted bolts and the disc itself will be bolted to the forged flanged end of the main shaft with turned and fitted bolts.

Safeguards Against Sudden Pressure Changes

On these units, the servo motor of the governor is mounted directly on the nozzle pipe itself and the piston is connected directly to an extension of the needle, a governor-controlled pressure regulator being provided which opens whenever the governor causes the needle to close. A rate-limiting device is provided on the governor so that the change in velocity is the same for each fraction of time of the total stroke of the governor and the pressure regulator is designed to open an amount which will exactly compensate for the decrease in flow caused by the closing of the needle itself. The pressure regulator is designed to close slowly after opening and at such a rate that serious pressure rise will not be set up in the long pipe line. The water from the pressure regulator, at a pressure of approximately 1000 lb. per sq. in. and with a spouting velocity of nearly 400 ft. per sec. or the equivalent of over 260 miles an hour, discharges into an energy absorber, which turns the water through 180 degrees, allowing it to discharge with practically all its energy destroyed, so that it does not undermine the foundations and wear away the concrete.

Gate valves on these units will be of the hydraulically-operated type and will be fitted with slot-filling follower rings so that when the valves are in the open position, the water passages will be perfectly smooth and of the same diameter as the penstock entering the valve. The control of the hydraulically-operated mechanism will be electric, so that the valves may be opened or closed from the switchboard or by hand at the valves themselves.

To the casual observer, after a hasty comparison between the high-head units constructed in 1906 and those designed and constructed in 1925, it might seem that progress has been negligible but such is not the case. Gain of at least 6 or 7 per cent has been made in the efficiency of high-head Francis turbines during the last 20 yr. and at least 4 to 5 per cent in the efficiency of impulse wheels during the same period. The many refinements in design and construction, which may appear slight at a casual glance, have been made only after careful study and consideration of many and varied designs. High-head units of today are much easier to operate. Their control is more reliable and their auxiliary apparatus has been simplified to such an extent that the possibilities of shutdown due to failure of this auxiliary apparatus are far less than with the units designed 20 yr. ago. It is probable that the next 20 yr. will see other changes and simplifications in the design of high-head units but just what these changes will be it is difficult to foresee.

Not much is likely in the way of a gain in efficiency but it is reasonable to expect that capacities even larger than 40,000 hp. per unit for impulse wheels and 70,000 hp. per unit for Francis type units will be obtained, and it is probable that greater simplifications in the arrangement of these machines will be developed in order to make their operation more simple and reliable.

Feed-Water Deaeration Increases Plant Economy

Deaerators Are Insurance Against Corrosion and Replace Other Equipment. By J. R. McDermet

DEAERATION, as practiced in the modern power plant, is primarily an insurance feature. It makes possible, by affording corrosion protection, the use of economizers, extra high boilers, and other equipment which, in turn, yield appreciable increase in economy. From the standpoint of heat conservation, modern deaerators fit into heat balance cycles without subtracting from their efficiency; in some few cases, they may actually improve it. The operating costs are interest on investment and maintenance.

Deaerators Also Heat Feed Water

It is possible to design a power station and secure these insurance advantages by other arrangements of apparatus. Deaerators are not, to the modern designer, altogether imperative but, ordinarily, they represent the simplest and most straightforward layout and, simultaneously, the cheapest, as apparatus employed for avoiding their use is usually more costly than the deaerating equipment. Deaerators in a feed-water heating cycle supplant other apparatus but they do not change the essential relationship of heating means, neither do they detract from the heat utilization possible and, from the standpoint of operation, they represent arrangements which have been evolved from practice and found useful.

Protection Is Given to Boilers, Economizers and Turbines

Without oxygen-free feed water, the high pressure, steel-tube economizer is impractical. With deaerators, it is possible to operate high-pressure boilers and economizers at central station rating for periods of at least 1 yr. without depreciating the interior surfaces in the least from the condition in which they were received from the manufacturer. Air preheaters have, to some extent, superseded the economizer but the advent of higher steam pressures and higher flue gas temperatures has simultaneously broadened the field of the economizer by limiting the field of the air preheater. Doubtless, in future stations, both will be used, each in its particular sphere of usefulness.

Some types of boilers, particularly those with high tube banks, where boiler heating surfaces serve virtually as economizer surface, may experience corrosion equivalent

to that occurring in the steel-tube economizer. It is possible to protect these boilers also and make their life indefinite, up to the time of obsolescence.

Incidental uses will probably develop in connection with the operation of steam turbines. It has been definitely proved that, in the saturation zone of the turbine, corrosion, which is the forerunner of erosion, will not occur in the absence of dissolved oxygen. Operating procedure in shutting down and in holding a turbine idle, have, however, prevented the practical determination of whether deaeration will altogether prevent turbine erosion.

In closed exhaust systems, such as paper mills and textile plants, deaeration has found its uses in improving the conductivity of radiating and heating surface by eliminating air binding and has protected condensate return lines against the ravages of oxygen-polluted water.

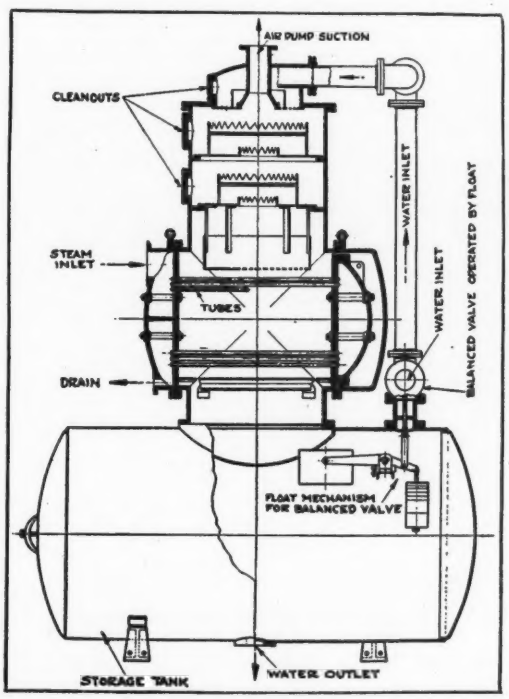

FIG. 1. THIS CONTRAFLO DEAERATOR INCORPORATES A WATER FILM DISTRIBUTION, CLOSED TUBULAR HEATER, SEPARATING CHAMBER AND STORAGE TANK IN A SINGLE UNIT, AIR AND GASES BEING DRAWN FROM THE TOP. STEAM MAY BE DRAWN FROM ANY STAGE AS THE HEATING MEDIUM

Indirectly, therefore, the art of deaeration may be credited with the heat economies secured through the use of economizers and high boilers. Undoubtedly, it is makin the life of turbine structures longer; likewise it is permitting the use of exhaust steam in extensive pipe work and permitting the return of hot condensate for boiler feed, with consequent heat economy. In all fields, it is lengthening the life of equipment over that obtained in days before the advantages of oxygen-free water in a power plant were realized.

All types of deaerators, as manufactured by different companies, are adapted to secure the greatest return upon the heat economy devices with which they are designed to operate. In the flash type deaerator, for illustration, where the water is preheated and flashed into a vacuum, the advantages gained are deaeration with a reduction of temperature over the initial feed heat but without any loss of heat. These deaerators find their maximum usefulness in the type of station where large economizer areas are installed and the feed water temperature is kept low for the purpose of securing the maximum temperature differential in the economizer. If conditions of operating personnel and reliability require the use of steam-driven auxiliaries, the duty of heating the water may be transferred to the economizer, with an improvement in overall efficiency. Flash type deaerators recognize this fact and contribute to the realization of temperature and at the same time effect the oxygen removal.

Inter-stage reheating of feed water, by steam extracted from the turbine on the regenerative principle, is becoming increasingly popular with the power plant designer.

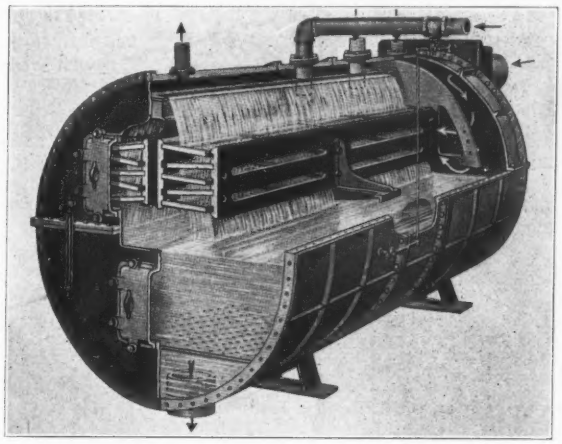

FIG. 2. IN THIS DEAERATING HEATER AIR AND OXYGEN ARE DISSOCIATED AT TEMPERATURES OF 130 DEG. F. OR ABOVE, HEATING BEING BY DIRECT CONTACT OF EXHAUST STEAM WITH THE WATER

It has improved the thermal efficiency of the turbine markedly while it has been found possible to effect other economies in the boiler installation, and, by the use of economizers or air preheaters or a combination of the two, to retain this economy gain.

Several different types of deaerators are available to fit in with the regenerative or extraction heater cycle, in which the functions of the deaerator and the corresponding stage heater are incorporated. The deaerator is provided with an internal closed feed-water heater of the steam-tube type, to which steam is admitted from the turbine extraction stage. The steam tubes heat their water to the temperature of the corresponding closed feed-water heater, which would otherwise be installed, and simultaneously supply enough heat to the integral deaerating tray section to perform deaeration. Water storage may be provided for the boiler feed pump suction. These deaerator units take the place of the stage heater, retain the advantages of the stage heater in heating the feed water and yet keeping it from contact with the steam and, at the same time, deaerate it. Protection is afforded, not only to the boiler equipment, but to the high-pressure heaters following in the cycle as well and the cost of these, on a square foot basis, when built for high pressures, is sufficient to warrant protecting them.

Paper mill and textile plants, with their large quan-

tities of hot condensate return for boiler feed purposes, are doubtless responsible for the development of the double-chamber, open-contact type of deaerator unit. This is, in addition, the most perfect of feed-water heating mechanisms, from the standpoint of temperature depression. Temperature differences between heating steam and water delivered are so small as to be almost impossible of measurement. Probably for this reason, the open-contact, double-chamber unit has been used on turbine extraction work, the superior temperature elevation compensating for the elaborate devices needed to prevent water risk to the turbine from which steam is extracted.

Costs and Durability

Average cost of deaerator equipment, crediting it for the saving in other heater equipment displaced, varies at the present time from 70 to 90 cents per boiler horsepower developed. The depreciation rate upon the deaerator equipment has, however, not yet been established, since the entire art does not date back more than 5 yr. Observation of equipment which has operated for such period indicates that, with the exception of heating trays employed, the equipment will last until the boilers become obsolescent. Tray life appears now to be approximately 12 yr.

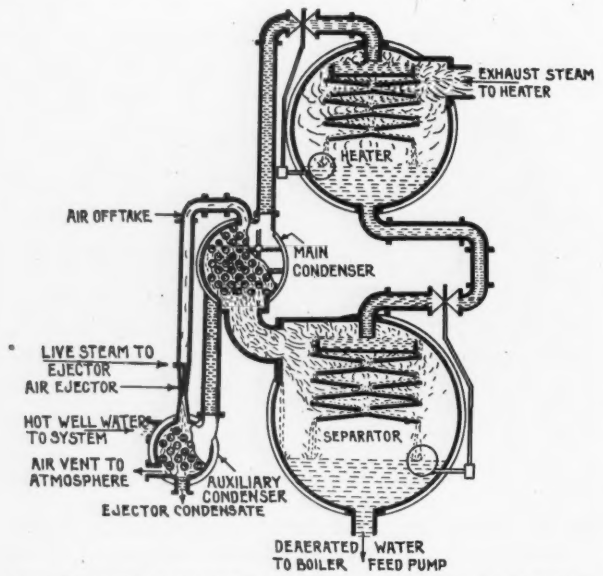

FIG. 3. DOUBLE-CHAMBER DEAERATOR WHICH HEATS WATER BY EXHAUST STEAM, THEN DELIVERS IT TO A SEPARATOR WHICH IS UNDER VACUUM WHERE WATER BOILS VIOLENTLY, RELEASING AIR, GASES AND SOME VAPOR. THESE ARE DRAWN INTO THE MAIN CONDENSER, THE VAPOR CONDENSED AND RETURNED TO THE SEPARATOR AND AIR REMOVED BY STEAM EJECTOR TO AUXILIARY CONDENSER WHERE EJECTOR STEAM IS RECLAIMED AND AIR DELIVERED TO ATMOSPHERE.

The success of deaerating equipment in positively preventing corrosion in the large power station has resulted in a demand for a cheaper type of unit than the deaerator, and has resulted in the marketing of a Deaerating Heater, which is nothing more than a deaerator modified to secure lower cost. If of the double-chamber, open-contact type, it is sure to be superior as a heater to the open feed-water heater which it displaces, and costs approximately 40 per cent more, judged from the standpoint of the cost of the corresponding open heater. The average small steam plant, at some season of the year, usually furnishes exhaust steam heat and the equipment which the deaerating heater protects is much more expensive than the boilers, themselves. The cost of the protection is much less than other types of risk protection and it is constructive, likewise, in that it is not necessary to lose in order to be repaid.

Department of Commerce Issues Stoker Report

IN A REPORT on mechanical stokers, recently issued by the U. S. Department of Commerce, interesting statistics are included on the number of stokers sold, the horsepower and the kinds of installation. These are compiled, for the first 10 mo. of 1925, from data supplied by 13 establishments. For comparison with these, the data on the same subject for 1924 and the last 3 mo. of 1923 are presented in the accompanying table, which gives a monthly record of stoker sales from Oct. 1923, through Oct., 1925.

STOKERS SOLD, HORSEPOWER AND KINDS OF INSTALLATION

Year and month	Establishments reporting (number)	Stokers sold		Installed under—			
				Fire-tube boilers		Water-tube boilers	
		Number	Horsepower	Number	Horsepower	Number	Horsepower
1925							
October	13	114	53,451	22	3,864	92	49,587
September	13	119	38,155	34	7,563	85	30,592
August	13	91	29,865	27	3,880	64	25,985
July	13	147	58,719	30	5,075	117	53,644
June	13	128	44,095	26	4,625	102	39,470
May	13	122	55,588	23	3,934	99	51,654
April	13	120	47,627	23	5,893	97	41,734
March	13	131	71,099	17	2,446	114	68,653
February	13	135	46,298	28	4,905	107	41,393
January	13	57	27,871	4	870	53	27,001
1924							
December	13	91	31,732	18	1,788	73	29,944
November	13	106	37,167	11	1,675	95	35,492
October	13	104	58,565	7	1,702	97	56,853
September	13	73	25,988	27	6,646	46	19,342
August (1)	13	94	41,931	17	2,486	77	39,445
July	15	115	37,759	14	1,660	101	36,099
June	15	103	35,549	19	2,724	83	32,825
May	15	64	34,447	3	550	61	33,897
April	15	89	47,939	15	1,970	74	45,969
March	15	89	34,597	12	1,626	77	32,972
February	15	119	62,113	11	1,525	99	60,588
January	15	91	65,492	7	1,044	84	65,448
1923							
December	15	73	32,517	17	2,820	56	29,697
November	15	50	16,241	10	1,300	40	14,941
October	15	88	32,576	14	2,330	74	30,246

(1) Two establishments consolidated with other companies.

During the first 10 mo. of 1925, 1164 stokers were sold; these were placed under boilers with a total capacity of 472,858 b.hp. Of these, 234 stokers were installed under 43,055 b.hp. of fire tube boilers and 930 under 419,714 b.hp. of water tube boilers. During the whole of 1924, there were 1128 stokers sold, installed under boilers a total of 514,279 b.hp. Of these 161 stokers were installed under 25,395 b.hp. of fire tube boilers and 967 under 488,924 b.hp. of water tube boilers. In October, 1923, a total of 88 stokers was installed under 32,576 hp. of boilers; in Oct., 1924, 104 stokers were installed under 58,565 b.hp. and in Oct., 1925, 114 stokers were placed under 53,451 b.hp. Comparisons of the totals for the other months can be readily made from the table.

ALL FUEL STORAGE tanks should be vented to the atmosphere and provided with some sort of fire extinguishing apparatus, either steam smothering system or foamite apparatus. It goes without saying that water should never be used in an attempt to quench an oil fire.

Rural Power Use Is Increasing Rapidly

FURTHER POSSIBLE EXTENSION REQUIRES THOUGHTFUL PLANNING TO ATTAIN BEST RESULTS AND DEVELOP THIS HUGE MARKET FOR CURRENT. BY DR. E. A. WHITE*

DURING THE past 2 yr., work by various agencies interested in rural electrification has resulted not only in a few conclusions coming to be generally accepted but, what is of vastly greater importance, a general clearing of the haze with which this proposed development has been obscured. Where two years ago the general refrain was "It can't be done,' today we are hearing "How can it be done? It must be done." A positive attitude of mind, a determination to succeed, is the first step in the successful solution of any problem. This has been established, not

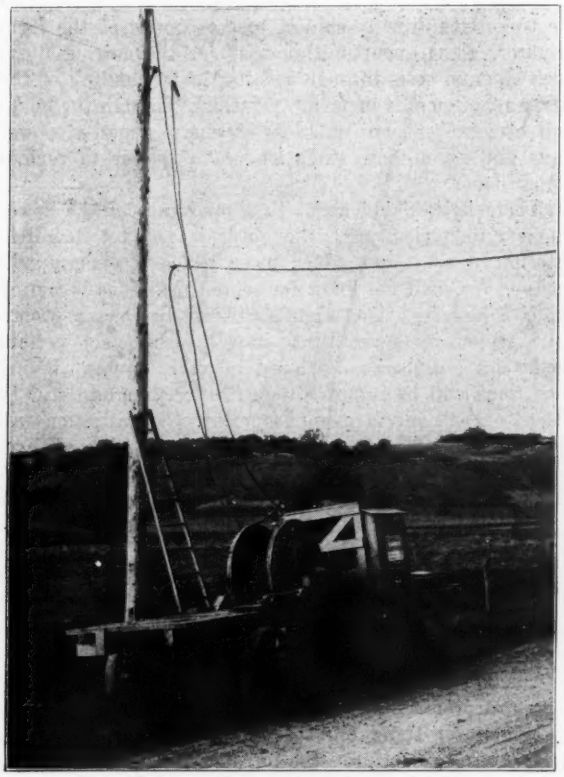

FIG. 1. CURRENT CAN BE TAKEN FROM ANY POINT ON A 2300-V. LINE BY PORTABLE TRANSFORMER AND MOTOR FOR USE IN THE FIELD

100 per cent, but in a sufficient amount to insure an active leaven. Today electric light and power companies are appointing qualified men whose sole duty relates to the supervision of rural electrification development. Committees are at work with constructive programs. Not only the Rural Electric Service Committee of the N. E. L. A. and the national committee on the Relation of Electricity to Agriculture, but seventeen state committees on the Relation of Electricity to Agriculture spread from New Hampshire on the east to California on the west, from Alabama in the south to Minnesota on the north, with a goodly representation in the corn belt.

Study of the possibilities for the use of electricity on the farm has become an established project in agricultural experiment stations. Farmers, agricultural leaders, electrical men, manufacturers are at work on this problem. Such efforts properly co-ordinated are certain to bring results of some kind.

In fact, we already have rural electric service and every month sees more rural lines built. The prospects are that the coming year will bring a marked increase in the number of farms having electric light and power service available. It is no longer a question of whether this thing should be or not; it is. The real problem is how to secure maximum results at minimum expense.

Today, there are at least 1,500,000 farms within reasonable reach of primary distribution systems. This is somewhat less than one-fourth of the total number of

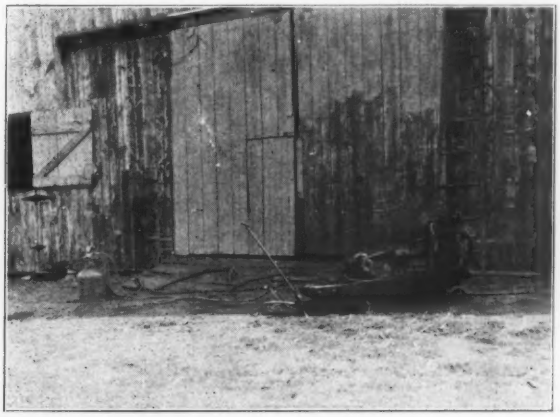

FIG. 2. THIS MOTOR-DRIVEN COMPRESSOR WAS USED FOR AIR-BRUSH PAINTING OF FARM BUILDINGS

farms. With an average of three farms per mile this means 500,000 mi. of rural distribution lines—enough to reach 170 times across this continent—and, at the minimum figure of $1000 per mile, will represent an investment of $500,000,000.

But building transmission lines is not rural electrification. It is only one step. To become effective, electricity must be put to work on the farm. This requires the wiring of buildings, the purchase and installation of equipment. It is safe to predict that, to make electric service a dominant factor in agriculture, twice as much will be spent on the farms as in the building of rural distribution lines. Here is $1,000,000,000. Thus it appears that this is a $1,500,000,000 undertaking. It is a major development and deserves attention from vision and ability commensurate with its importance.

It is coming to be recognized by utility men who have given this subject exhaustive thought, that the first step is the development of a rate system adapted to agriculture. There is logic in the argument that there should be no more relation between a rural rate and an urban household rate than there is between the urban household rate and the commercial rate. A number of rural rates have recently been developed. The general tendency is for these rates to contain a minimum charge in some form considerably higher than in the case of urban rates and

*Director, Committee on Relation of Electricity to Agriculture.

taper off rapidly to low energy rates. The attempt is made to divide the rate into fixed charges and an energy charge on the kilowatt-hour basis.

Following the establishment of a satisfactory rate, electric light and power companies are organizing to put a comprehensive plan behind their rural service programs. During the past year at least six prominent companies have appointed men to have sole charge of this work. One company has gone further and established a rural service department. Conceptions are growing. This is indicated by the fact that in some cases rural electric districts are being mapped out and distribution systems planned to make service available to every resident in the district. Then it is no longer rural lines but rural districts.

Results from the experimental lines in operation over a year indicate that an electrical load of desirable proportions may be built in agriculture. In Minnesota, with

FIG. 3. AWAY WITH THE BUCK SAW. SIX CORDS OF WOOD IN 100 MIN. WITH THIS MOTOR-SAW OUTFIT

loaned farm equipment, the average consumption is in excess of 280 kw-hr. per farm per month. The maximum is over 500 kw-hr. On the Wisconsin line the average is over 300 kw-hr. per farm per month. On the South Dakota line it is 130 kw-hr. and climbing steadily. Reports have been received from dairy farms using 1000 kw-hr. per month.

All this is hopeful and clearly indicates that we do not yet know where the economic maximum may fall. Much more experimenting will be required before this can be even approximately determined.

There is still much to be done in properly adapting electrical-driven equipment to agricultural conditions or making changes in farm practices to take full advantage of electrical possibilities. It is one thing to perfect a mechanical device so that it performs an individual operation successfully, and sometimes quite a different thing to fit this machine into a practical agricultural system. Fortunately, the experiments indicate that with relatively few changes in existing equipment we can get a splendid start with the electric drive in agriculture. Progress is being made in this direction. A subcommittee of the national committee on the Relation of Electricity to Agriculture, consisting of representatives from both the electrical and agricultural equipment industries, is analyzing the situation. What may ultimately develop we do not know but some idea may be gained by looking back at the history of the introduction of the electrical drive into industry. It did not come all at once. The human race is so constituted that it must work for progress.

Recent appraisal of power used on farms in the United States reveals some interesting and significant facts. According to this report, Department Bulletin No. 1348, "Agriculture uses practically as much primary power as all manufacturing and central station plants combined. The cost of using this power amounted to approximately $3,000,000,000 for the year 1924. By the aid of this power, however, the average agricultural worker has been enabled to increase his volume of production nearly three times over the average of 75 yr. ago. Power and labor together represent on the average about 60 per cent of the total cost of carrying on the farm business and, since these are two items directly subject to the control of the farm operator, great opportunities exist for the cutting down of production costs through a better understanding of the power requirements of farm operations, through the adoption of more efficient and less expensive types of power units and by a more extensive use of power to replace human labor."

There is no doubt about the importance of the power problem to agriculture although it is not yet definitely determined as to the exact place which electricity will occupy. We shall not know for some time. It is becoming evident, however, that when electricity becomes a prominent factor in agriculture, it will accentuate certain tendencies now being developed by other causes. Living conditions will be improved. A further premium will be placed on efficient farm management. Capitalization will be increased. Changes will be made in the plan of farm operations to take advantage of the time saved or improvement in the quality of farm products made possible by electrification. The proportion of our population living on farms will further decrease.

This last point requires a little explanation. The spread of electric service is making it possible for more and more people to live in the country around large centers of population, while working in town. In many instances this is suburban service but in others it is part of the rural problem. While it should be considered there is no reason for being blind to the fact that, as in other fields, so in agriculture—the introduction of power means less man-hours required for a given operation. As power comes in, the percentage of our population making a living from farming may be expected to decrease.

To sum up the present situation, it is evident that for the electrical industry, the manufacturers, and the farmer, rural electrification is a major undertaking. Its limitations and possibilities are not fully understood today. For a satisfactory solution, vision, hope, and hard work will be required.

RECEIPT OF APPLICATIONS for first class steam electric engineman for service in government buildings will close December 29. The examination is announced by the United States Civil Service Commission and competitors will be rated on their physical ability, training and experience. The entrance salary is $1500 a year.

DON'T EXPECT a Diesel or semi-Diesel oil engine to burn dirty oil. Nozzle trouble constitutes 75 per cent of the causes of oil engine shutdowns.

Transmission and Distribution Lines---I

GENERAL FEATURES OF TRANSMISSION LINE EQUIPMENT WITH A DISCUSSION OF INSTALLATION AND MAINTENANCE METHODS. BY STEPHEN Q. HAYES*

PROPER INSTALLATION and maintenance of transmission and distribution line equipment on electric power systems is of great importance to the power company as a whole and to the operating departments in particular, so that a review of this subject seems well worth while. For this reason it is the intention to touch briefly on some of the more important features of transmission and distribution lines reviewing present practice and tendencies in these matters.

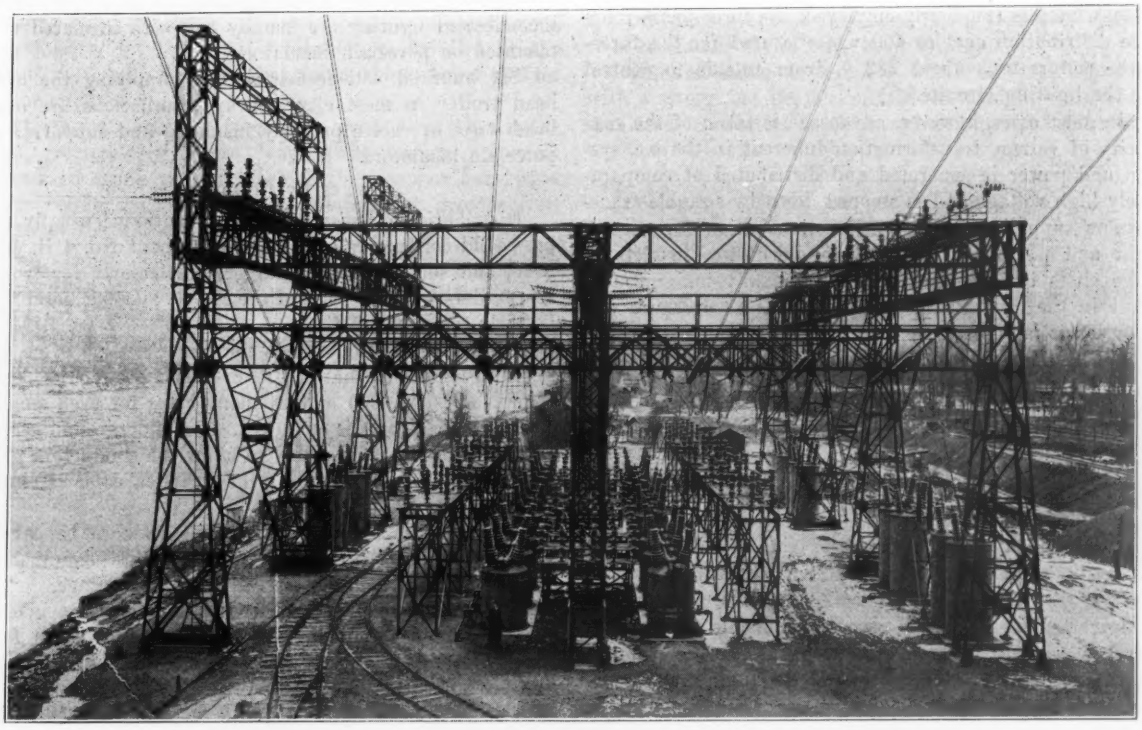

FIG. 1. TYPICAL EXAMPLE OF A MODERN HIGH TENSION SWITCHING STATION

When the first central stations were placed in operation, all energy was distributed by means of direct current and most of the original plants, like the Edison Pearl St. Station in New York, were designed for 110-v. service. As the economical distance that could be reached by this voltage was comparatively small the two-wire 110-v. d.c. distribution was soon superseded by the 220/110-v. three-wire system in the United States, while in Europe, particularly in England, the three-wire distribution was 440/220-v., thus allowing a still greater range. In some few instances five-wire direct current circuits were installed, giving 440/330/220/110 v., so that it was possible to use either 440, 220 or 110 v. direct current motors and incandescent lights either on 110 or 220 v.

Railway installations started with a nominal voltage of 500/550 v. and gradually increased to a maximum of about 650 v., where they remained for a number of years. On some of the larger interurban roads it was found advisable to increase the line voltage from a nominal 600 v. to twice this amount, or a nominal 1200 v. This in turn was gradually boosted to 1500 v. and for railway electrification work, employing direct current, the voltage has again been doubled so that such lines as the Milwaukee and a few others operate at 3000 v. d.c.

All of the direct current circuits previously mentioned are of the constant potential type. At the same time the constant potential direct current was being developed for light and power service, constant current of the series type was utilized for arc lighting with some series motors, and later for series incandescent service. The voltage on such direct current circuits, supplied either from generators, or more lately from rectifiers, may be in the neighborhood of 7500 v.

Low voltage direct current lighting systems using constant potential started out with overhead distribution of current owing to the lower first cost of such an arrangement. In the larger cities where the direct current service is still supplied to the congested downtown districts, underground cables have in most cases superseded these overhead distribution systems. The direct current feeders for railway service in city districts are usually run overhead except for the few cities like New York and Washington where the underground trolley is utilized and the feeder cables are kept underground to correspond. The interurban railways or the main line railway electrifications utilizing either 1500 v. or 300 v. direct current have their feeder and distribution lines almost invariably overhead.

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Direct current series system for arc lighting or incandescent lighting is essentially all arranged for overhead operation.

A. C. Distribution Voltages

With alternating current distribution the individual residence lighting circuits are almost invariably 110 v. two-wire, although occasionally 220/110 v. three-wire distribution is utilized with single phase circuits running along a residence street with alternate houses connected from each outside wire to the neutral. Occasionally, a three-phase four-wire distribution is used employing approximately 200 v. between phases for power service and approximately 116 v. from outside wire to neutral for the lighting circuits. In Europe where the 220-v. incandescent lamp is frequently employed, the three-phase four-wire distribution enables 400 v. to be used for the three-phase motors with about 232 v. from outside to neutral for the lighting circuits.

In most cases, however, advantage is taken of the simplicity of voltage transformation inherent in the a.c. system and power is generated and distributed at comparatively high voltage and is stepped down by suitable transformers supplying a low tension distribution for general light and power service. In the downtown districts of large cities the a.c. distribution is usually underground, while in the less thickly populated sections overhead distribution is more prominent.

While the earlier plants and the smaller installations usually limited themselves to approximately 2400 v. for generation and primary distribution, the larger and later plants have adopted higher generating voltages, such as 6600, 11,000 or 13,200 v. These voltages are usually sufficient to enable all of the power of the generating station to be delivered to the point of application with a reasonable amount of loss. Such distribution may be either overhead or underground depending on local conditions.

For the very large generating stations where power is developed in bulk, it is usually impossible to deliver to advantage all of the generated power at generator voltage to the ultimate consumer or the main substations, and for cases of this kind step-up transformers are installed and the power sent out from the generating station at a much higher voltage than that for which the machine could be conveniently wound.

Methods of Distribution

Where these generating stations have been built in the heart of the city, or on the bank of a river passing through a large city, the distribution voltage has been largely limited by the safe voltage for which underground cables could be readily obtained, as usually overhead high voltage lines are not permitted through the city streets.

Where the stations are not located in the city the high tension distribution is made by overhead circuits and there is no real limit to the voltage that can be utilized. The most economical transmission voltage can be selected.

For the overhead local distribution to domestic customers for lighting service where 110-v. two-wire, single-phase is employed, or 220/110-v., three-wire, single-phase, it is customary to employ overhead conductors suitably insulated with rubber or compound and supported on glass by porcelain insulators, the 2300-v. two-wire, single-phase, or three-wire three-phase main distribution, or the 4000/2300-v., three-phase, four-wire main distribution supplying power to customer's transformers utilizes insulated conductors run overhead and mounted on suitable porcelain insulators.

In certain cities even higher voltages, such as 6600, 11,000, or 13,200 v. have been run through the city streets, these conductors always being suitably insulated and supported on porcelain insulators. Occasionally the distribution transformers supplying power locally to residences or small shops are connected directly to these high tension circuits, but more often such 6600, 11,000 or 13,200-v. circuits supply current to a local substation and the distribution to the transformers for house service is made at 2300 v. or 4000/2300 v.

Constant current series circuits for arc lighting or incandescent lighting are usually run with insulated wire mounted on porcelain insulators.

Six hundred volt feeder circuits supplying the overhead trolley in most city railway installations are overhead wires or cables properly insulated and supported on porcelain insulators.

Types of Conductors

Distribution circuits previously mentioned usually employ solid conductors up to a size of about No. 4 B. & S. gage, and sometimes even larger, particularly for trolley line feeders where the use of the No. 4/0 (.460) solid wire is fairly common practice.

Solid wire, particularly in the larger sizes, is often difficult to handle so that for all overhead conductors larger than No. 4/0 (.460) and in many cases for even smaller sizes, stranded cable is employed. For underground service where flexibility is necessary to allow the conductors to be pulled through ducts, the use of stranded cable is almost universal.

Where large amounts of current have to be carried reasonably short distances bare conductors mounted on insulators can frequently be utilized to advantage.

In many power plants the connections from the generators to their oil circuit breakers have been run in the form of bare copper strap mounted on porcelain insulators. At the Nitrate Plant installed by the U. S. Government at Muscle Shoals during the War the main 12,000-v. distribution from the generating station to the nitrate plant was run in the form of bare copper strap mounted on porcelain insulators and located in a duct or tunnel between the buildings.

At a certain large steel works where current at 6600 v. was to be distributed to many mills, an outdoor distribution in the form of bare copper strap on porcelain insulators held on a steel structure ran to various sections of the steel mill.

At the Niagara Falls Plant of the Aluminum Company the conductors running from the generators to the aluminum furnaces comprised a large number of aluminum straps or plates in parallel, each strap or plate having a section of approximately 1 in. by 12 in.

In outdoor transforming and switching yards the high tension connections between the transformers, disconnecting switches, circuit breakers and busbars are often run in the form of tubing, either copper or iron, mounted on suitable insulators.

On these distribution circuits and transmission lines operated at high voltage, the use of bare conductor is almost universal and cable rather than solid wire is normally employed. These conductors particularly for the

lower voltages and smaller sizes normally utilize copper wire or cable.

As the voltage increases and the question of corona has to be considered, the external diameter of the conductor is frequently determined more by the corona effect than by the required conductivity. For cases of this kind and for a high voltage transmission using extremely long spans, aluminum cables have frequently been substituted for copper. In certain cases a steel core is employed with the aluminum cable to increase its strength and to permit the use of longer spans.

In certain other cases where long spans were needed and comparatively small current carrying capacity was required, copper clad steel wire has been utilized to advantage, as such wire has the mechanical strength needed for long spans due to its steel core and has sufficient carrying capacity for the small current to be handled by the use of the layer of copper that forms the external surface of the conductor.

Aluminum cable is frequently used for transmission lines, particularly where long spans are to be used. Aluminum cable is much lighter than copper but has a lower conductivity for the same area but greater conductivity for the same weight.

For equal conductance, aluminum cable weighs approximately 48.3 per cent of copper cable, so that for long spans the use of aluminum reduces the weight to be carried by the supporting towers. For very long spans pure aluminum has certain drawbacks as the elastic limit and the ultimate strength of aluminum is less than that of copper, and for equal conductance the breaking load of the aluminum cable is 64 per cent that of copper.

Great improvement in the strength of aluminum cable is obtained by using a steel reinforcing strand for small cables or a stranded steel core in larger cables around which the necessary amount of aluminum is placed. The steel is double galvanized so that it does not readily corrode and it greatly increases the mechanical strength so that steel reinforced aluminum cable having sufficient aluminum to give conductance equal to copper cable will have an ultimate strength 34 per cent greater than the copper and will weigh only 72 per cent as much as the copper.

For most distribution and transmission circuits at moderate voltages it is customary to insulate the copper conductors that are used with underground cable in dry places and essentially all overhead cable. The insulating materials usually comprise rubber or some rubber compound that is directly exposed to the weather or is covered by a braid of suitable material.

For underground work where moisture is apt to be met with, it is customary to provide the cable with a sheathing of lead to keep out moisture and often this lead sheathing is protected by an outer layer of jute and sometimes by steel armor.

For underground service where a lead sheathing is to be provided for protection against moisture the insulating material of the cable instead of being made of rubber is frequently made of varnished cambric or of impregnated paper, each of which materials has its own special characteristics, and has certain advantages over rubber insulation, such as increased current carrying capacity, reduced cost, etc. With either varnished cambric or impregnated paper insulation, particular care must be taken to keep moisture out of the cable as moisture has an exceedingly deleterious effect on such insulating material, particularly the paper.

All joints in the cable must be carefully made and tightly sealed so as to prevent the entrance of moisture. All such cables usually terminate in potheads that allow the cable to be sealed off so that moisture cannot enter.

Where underground cable is employed for three-phase service, it is customary to utilize three conductor cable with all three phases suitably insulated from each other and from ground but all contained in the same lead sheath. The joints for such three-conductor cables and the potheads where they are separated into individual conductors have been worked up in very great detail in order to secure the most satisfactory arrangement. Occasionally for single-phase work a twin cable is employed and sometimes for two-phase work or for three-phase, four-wire systems, four conductor cables have been employed.

Armored cable is suitably insulated cable provided with a strong but flexible metallic covering to protect the insulated conductors against violent mechanical stresses.

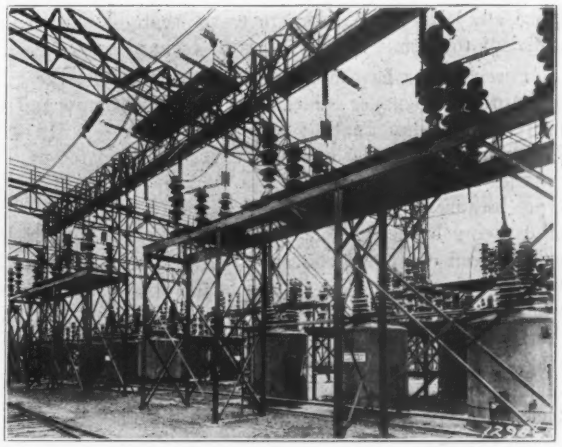


FIG. 2. A CLOSEUP OF SOME OF THE APPARATUS SHOWN IN FIG. 1

The armor usually consists of galvanized steel or iron tape or wire wound around the outside of the cable. When armored cable is to be put in directly in the ground or in a body of water, one or two layers of impregnated jute are usually placed over the armor to protect it from rusting or corrosion.

Low voltage cables placed in ducts or exposed where high temperatures are encountered are frequently covered with asbestos. The cable is generally stranded and a thick coating of asbestos is applied and saturated with a cementing compound. An outer covering of cotton braid or braided asbestos yarn is then applied and treated to prevent the injurious action of water, heat or gases.

As a joint between a lead sheathed underground cable and a station or indoor cable, end bells are usually provided. They consist of an inverted bell or cupped shape metal disc that fits snugly over the end of the cable sheath to which it is joined by wiped joints. The bell is filled with sealing compound to protect the underground cable against the entrance of moisture. The top of the end bell is usually open, although often covers are provided. The earlier type of brass open top end bells have largely been superseded by cast iron bell tops with covers. These usu-

ally are spoken of as potheads. The cover carries suitable porcelain tubes to insulate the individual conductors as they emerge from the pots. With the indoor type of pothead the outlet tubes are of corrugated porcelain, the size and spacing being made suitable for the voltage. Outdoor potheads are provided with longer tubes and the pots are protected from moisture by a porcelain cap which prevents current leakage from the line to the metal of the pot.

Wherever cables are exposed to acids, gases, steam temperature changes, or other destructive agencies, it has been found advisable to encase the cable in a lead sheath. The conductors may be insulated either with rubber, cambric, paper or other material. The lead sheath is applied by passing the cable through a die surrounded by lead which is kept at a temperature just low enough to maintain it in a solid state, a slight increase in temperature causing it to melt. The lead is applied under hydraulic pressure and is formed into a smooth uniform coating by the die. The cable is fed through slowly, sometimes directly from a drying oven as dry core paper insulated cable, and as it emerges from the die is coiled on a large reel some distance away, the time taken to travel that distance being sufficient to permit the lead sheaths to harden.

Power cables have been made lead covered in the case of impregnated paper cables to keep out moisture and to prevent the impregnating compound from flowing out. Impregnated paper lead covered cables are used for underground transmission to the practical exclusion of other types because of lower costs, lower dielectric loss and higher carrying capacity. Varnished cambric and rubber insulated lead covered cables are used at medium and lower voltages where dielectric loss is negligible and for places where the cable sheath is broken for joints frequently as in distributing mains and in the short connections used about stations and substations. Varnished cambric and rubber insulation do not readily absorb moisture and can be protected at terminals by taping and painting.

Single conductor cables are used for the larger sizes required in low tension systems and for distributing mains where there are many taps to be made. Duplex, triplex and quadruplex cables are used for feeders on two-wire, three-wire and four-wire systems.

Rubber insulated cables usually have a covering of saturated cotton braid and this braid while satisfactory for indoor service usually does not last very long for outdoor service.

Cables insulated with varnished cloth or cambric have greater carrying capacity than rubber insulated cables of the same size. They are made by winding thin varnished cotton or muslin tape around a stranded conductor. The voltage requirements determine the number of layers applied. A grease or insulating compound is applied between layers and the direction of winding is reversed every few layers. In the case of multiple conductor cables the separately insulated conductors are cabled together using jute filler to round out the shape and it is then customary to place a few layers of varnished tape around the cable before the protective covering is applied. This covering may be a cotton braid or rubber filled cotton tape, flameproof braid or a lead sheath either with or without steel armor.

(Note. This is the first of a series of four articles on the subject of transmission line practice. The others will appear in subsequent issues.—Editor.)

Protecting Furnace Metal Parts from Oxidation

By Hugh E. Weightman

PROTECTING metal surfaces from oxidation by the process of projecting aluminum into the metal with a metal-spraying apparatus has proven to be a commercial success. This process is especially useful in coating iron castings. The process introduces a thin aluminum coating into the metal. The section through the treated metal shows a combination of the iron and aluminum and at the outer skin a pure aluminum-oxide coating is produced. The oxide coating has a melting point of 3200 to 4000 deg. F. This process will allow the operation of iron at much higher contact temperatures in an oxidizing atmosphere without the consequent loss of unprotected iron.

One disadvantage of the process is the necessity for replacing the coating from time to time. The metal-spraying equipment must be operated by technical labor. In some cases it is impossible to get the apparatus close enough to the iron parts owing to the heat of the furnace, even when not under operation. The latter is the case in heating furnaces used in steel mill practice, using silica brick roof structure. In this case the furnace must never be allowed to cool below a red heat. Door jambs on such furnaces wear out by scaling. In boiler plants the grates and stoker parts in contact with the fuel cannot be conveniently treated with the metal-spraying apparatus.

To overcome this objection, a new process for treating metal parts of furnaces has been developed by the writer in which no spraying apparatus is needed. The process consists in treating the metals with a slip made of an aluminum-iron-titanium mixture with sodium-metasilicate.

For new parts, the castings are washed in a caustic solution to remove grease, oil and sand; then washed in water; after which the parts are dipped into the above mentioned slip or slurry. The slip dries almost immediately so that the parts may be installed without delay. Where door jambs, grate bars and similar parts are already installed they may be cleaned sufficiently with a steel brush and the slurry painted on with a paint brush or sprayed on with an ordinary paint spray machine.

Addition of an oxide coating on materials while offering many advantages is not a permanent proposition and the coating must be replaced from time to time. For that reason the process which uses only the simplest of tools and admits the widest application will find the widest use.

An application has been made to the fire side of a coal fired rotary dryer used in a powdered fuel installation. The material was applied with a paint brush after having scrubbed the surface slightly with a steel brush to remove large iron oxide scales. This dryer has been in operation for 2 yr. with only two coatings. The second coat was applied one month after the first coat as added precaution. The dryer is still in operation without any further signs of scale formation.

Treating the grate bars in a hand fired marine boiler not only reduced the wear of the bars by some five fold but prevented the ash from fusing to the bars. This resulted in easier firing conditions. More perfect combustion was realized than was possible under previous conditions.

Monel metal pots were treated with this mixture with

a consequent better life in handling. Cast pots for annealing have been treated, and have shown that the pots so treated stand better as regards scaling, cracking and warping.

This process has been used as a protective coating to brick work in heat-treating operations. In this work it made a smooth surface, without the glassy surface, welding the brick into a mass. One clay pot manufacturer's crucibles have been treated in order that they might be used in the melting of monel metal. This has worked with a great deal of success. This has been the only molten metal work in which the process has been tried.

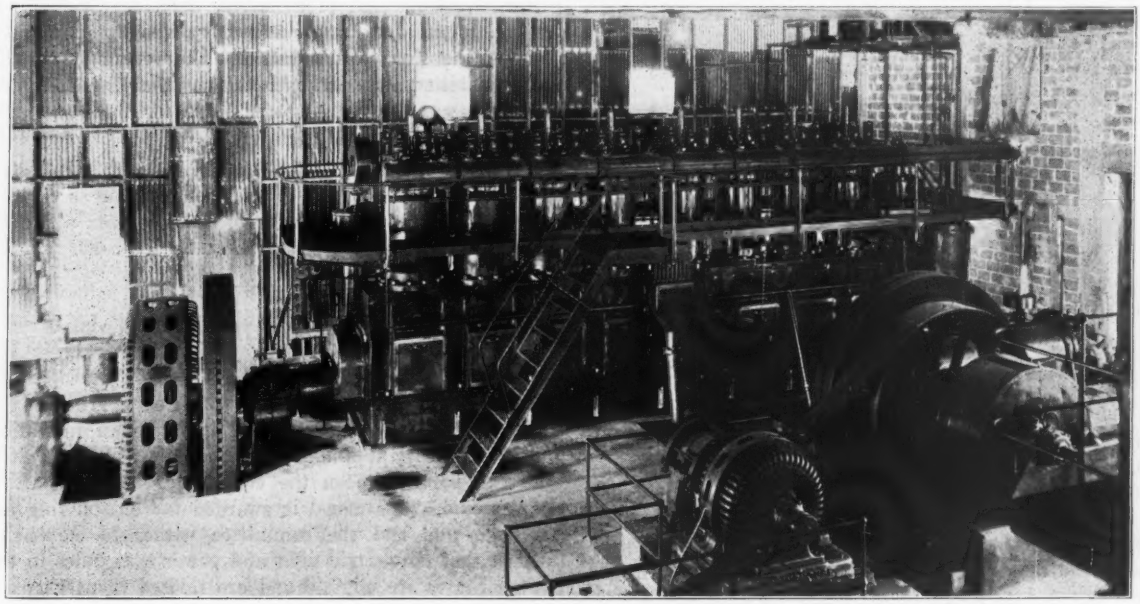
The composition can be conveniently made of ilmenite and diaspore or ilmenite and other high alumina clays or shale. The massive high alumina shale is superior to the use of aluminum oxide. Alunite can be used after considerable preparation though the potash bearing clays are not as suitable as soda clays. Magnesia should be avoided in any clays used in the process. This is also true of mica bearing minerals. The quantity and type of sodium silicate used will vary with the different minerals used in making the mixture. Care is required in this selection, otherwise the slip will peel from the casting. In any case, the slip is applied exceedingly thin.

Growth of the Diesel Engine Field

BUILDING UNITS OF BOTH LARGER AND SMALLER SIZES HAS OPENED NEW FIELDS FOR DIESEL ENGINES DURING THE PAST YEAR. BY RALPH C. PAUL*

DURING THE past year, the increasing field for the use of Diesel Engines has made an interesting subject for study to those who have been in a position to watch the developments. The field has widened from many points of view; larger sizes are being built due to the development of the double-acting engine; smaller sizes are being built; all sizes are being put to new uses and, finally, large numbers of steam installations, which have run for years unmolested, now find themselves on a new competitive basis because of the change in the fuel situation.

Acceptance of Diesel engines as prime movers is subject to competition as are all commercial articles in this present day. The question of dollars and cents is the final determining factor in the selection of equipment for power plants. Authorities agree that there is a field, a definite field, for Diesel engines and a definite field for large steam units, but the struggle is in the middle ground and where the limits lie is influenced largely by the fuel situation.



THIS EIGHT-CYLINDER, 800-HP. DIESEL ENGINE GENERATING UNIT IS TYPICAL OF MANY BEING INSTALLED IN SMALL CENTRAL STATIONS

With a Diesel engine the fuel cost is such a relatively small part of the total that moderate changes in the price of fuel make little difference in the unit cost of power. Then, too, there is comparatively little fluctuation in the price of fuel oil due to fundamental reasons. Labor costs hardly enter into the price at all. Supply and demand have more to do with it, with freight having some influence. The supply is governed almost entirely by the amount of gasoline we burn; for the more gasoline needed for automobiles, the more fuel oil there is available for Diesel engines. The ratio of increase of automobiles to the increase of units consuming fuel oil is so largely in favor of the automobile that the demand for fuel oil has little opportunity to catch up to the supply. Hence, a marked increase in the price of fuel oil cannot be looked for in the near future. Again, the method of taking oil from the ground tends to make the price of oil steady. With crude oil, once the pool is tapped, the flow cannot be stopped without serious detrimental effects to the well.

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This leads one in his study of the field of the Diesel engine to the consideration of the future supply of oil, the question about which those who have a limited knowledge of the facts are greatly concerned. Opinions have been expressed by many that our natural supply of petroleum will soon be exhausted. Reference to the reports of the Geological Survey discloses the fact that there is little to fear of a shortage for a long time to come. Oil fields which are being operated at the present time will supply the demand for a number of years, and there are oil fields in the United States alone which are known and are not as yet operated, and which will take care of the future, not considering the vast and unexplored petroleum resources of Canada, Alaska, Mexico and South America. When all this supply has been exhausted, there is the almost limitless supply of oil from oil shale which is now being developed on a commercial scale, to supply us for years to come. Fuel supplies and prices have large influences on the field of Diesel engines.

Sizes of Diesel Units Extending

Development of smaller and larger units has greatly increased the field of the Diesel engine. At one time the ordinary limits to the available size of engines were between 150 b.hp. and 1000 b.hp. These limits have been extended both ways until now units are available in very small sizes as well as sizes up to 8000 or 10,000 hp. Four-cycle air injection full Diesel engines are now being built in small sizes which will burn the same grade of fuel oil that their big brothers will.

In larger sizes, the development has been particularly interesting. This increase in size has been accomplished in a number of different ways. First engines are built larger, that is, larger bores and longer strokes are now being used than were hitherto considered advisable. This has been possible because of a better understanding of the problems of design. Also, there has been a steady increase in the number of cylinders; at first a four-cylinder unit was considered a Diesel engine, but gradually this has been increased so that even 10 and 12-cylinder engines are no longer unusual. In light weight high speed engines these are arranged in conventional "V" type, that is, alternate cylinders at an angle with each other, but on the larger heavy duty units, these 10 and 12 cylinders are in line, and they have proved to be as successful as the 4-cylinder units.

Again, the increase in power per unit has been accomplished by the double-acting engine, that is, power is applied to both sides of the piston. Use has been made of a stuffing box around the piston rod similar to the old steam engine practice. This principle has not offered any unsurmountable difficulties though there have been problems in design of combustion space, valve gear, piston cooling and piston rod stuffing box which have had to be carefully worked out. These double acting engines are developed and are now being built by a number of engine builders. A number are being built for converting existing ships to motorships.

New Uses of the Diesel Engines

Not only has increasing the range of sizes of the Diesel engine widened its field, but this type of engine is being put to new uses both afloat and ashore. As well as long run freight and passenger boats, Diesel engines are now used in numbers in special services such as ferries and tugs. They are particularly well adapted to this service because of their reliability and because of the absence of stand-by loss when tied up to the slip. In dredges, particularly large dredges, the Diesel engine is used almost universally.

Using Diesel engines in large power plants for running auxiliaries is a recent development. Where more power is required in the station, but it is not desirable to destroy the heat balance, the Diesel engine has been found adaptable. Where they have been tried the cost per kilowatt-hour of current produced by these units has compared favorably with the cost of current produced by the large steam units.

It is recognized that Diesel engines adapt themselves well as standby units for all services, due to the availability of full power at short notice and the absence of operating cost when the unit is idle.

A comparatively new use for Diesel engines in this country is found in the railroad business. In this field Europe is undoubtedly farther advanced than we are in America for, while Diesel electric cars and Diesel locomotives are somewhat of a novelty here, they have been in operation 10 or 12 yr. and are an accepted fact in many of the European countries. The economy, cleanliness, reliability, ease of operation and ability to make long runs without stopping to re-fuel or for water are features characteristic of these units.

It would appear that if the Diesel engine industry were to grow and progress in the year to come as rapidly as it has in the past year or two, developments will take place which may revolutionize the power industry.

Coffin Prize Committee Makes Announcement

The Charles A. Coffin Prize Committee of the National Electric Light Association offers an invitation to the electric light and power companies of the United States to participate in the contest for the Charles A. Coffin medal. This medal is awarded for outstanding accomplishments and the committee wishes to emphasize the fact that all electric light and power companies in the United States are eligible and are invited to participate.

Under the terms of the Charles A. Coffin Foundation, as established by the General Electric Co., the award will be made to that company which, during the year 1925, has made a distinguished contribution to the development of electric light and power for the convenience of the public and the benefit of the industry. All companies participating are requested to file statements or exhibits of their outstanding activities. Although the exhibits and statements should relate to the year 1925, the committee will consider any achievement which is the result of any previous effort but has reached its fruition during this year.

The award of both the Charles A. Coffin medal and the $1000.00 for the employes' benefit or similar fund for the year 1925 will be made at the 1926 convention of the National Electric Light Assn. at Atlantic City, N. J., May 17 to 21, 1926. All statements should, therefore, be filed with the committee not later than April 1, 1926, and should be addressed to the Charles A. Coffin Prize Committee, National Electric Light Association, 29 West 39th St., New York.

Pulverized Coal to Replace Hand Firing

DEMAND FOR INCREASED ECONOMY AND CAPACITY HAS LED THE LAMBERT TIRE AND RUBBER CO. TO BUILD A NEW BOILER PLANT

THREE OLD hand-fired, horizontal, return-tubular boilers at the plant of the Lambert Tire & Rubber Co., near Akron, O., must soon give way to a new pulverized fuel fired plant. The old boilers were built in 1907 and were installed as second hand boilers, at their present location in 1915. They are set in a battery and are connected to a brick chimney which measures 8 ft. square by 70 ft. high. They operate under a pressure of 100 lb. and supply steam for heating and process work. The water used conains about 15 gr. per U. S. gal. of scale forming matter and to date this has been successfully taken care of by the use of a sugar beet boiler treatment.

In making a preliminary survey of the situation, W. R. Gillam, chief engineer of the Lambert Tire and Rubber Co., found that the old boilers could not be operated at an average efficiency of over 50 per cent. This was on the basis of using coal which cost $4.00 at the boiler house and which was obtained from Nos. 6 and 7 seams of the Pittsburgh district. Further, the total steam capacity of these units was not enough to meet the manufacturing requirements, particularly in view of the fact that manufacturing facilities were being greatly expanded.

It was apparent that a new plant had to be constructed in order that enough steam might be had at a greatly reduced cost. On the assumption that a modern boiler installation, using slack coal costing $3.10 at the plant, would operate at an average efficiency of 79 per cent, it was estimated that an annual saving of $20,000.00 could be made on coal alone. Further savings would result in the labor and maintenance items as well as from the manufacturing departments being unhampered by lack of steam.

Electric power requirements are small as compared to the steam demand and it was therefore decided to continue to purchase electricity at least for some time to come.

The plant ultimately decided upon consists of two 422-hp. Stirling boilers, which will be fired by pulverized coal. These boilers are set with the center line of the mud drum about 14 ft. above the level of the furnace floor below the water screen. The furnace is built forward from the front drum and is covered by an American flat arch. The distance from the arch to the bottom of the furnace is about 22 ft. and the distance from the arch to the water screen is about 20 ft. The fuel is introduced through the arch by two burners. The distance from the front wall to the bridge wall is about 13 ft. 9 in. These dimensions give a furnace volume of 2500 cu. ft. or approximately 5.9 cu. ft. per rated horsepower.

The water screen, which contains 170 sq. ft. of heating surface, consists of eight tubes connected to front and rear water boxes. The rear water box is the higher of the two and is connected by means of three tubes to the upper front drum, while the front water box is connected by two tubes, one from each end of the mud drum. These connections to the mud drum are made above the center line.

Furnace wall construction will be of the hollow type and rigidly supported by a steel framework. Air will be admitted to the hollow wall near the rear and brought forward under the draft produced by the pulverizers. Dampered openings in the setting are arranged so that cooling of various portions of the walls will be under control of the operators at all times. The preheated air from the furnace walls will pass through sheet metal ducts to the pulverizers.

Flue dust will be caught in a concrete hopper from which it will be unloaded by gravity into wheelbarrows. The furnace ash will be raked out at the rear and used to fill in near the boiler house. At the rear of the setting a trench has been left in which an ash conveyor can be installed later should it prove to be a necessity or an advantage.

FIG. 1. STEEL FRAME WORK COMPLETELY SURROUNDS THE BOILER SETTING AND THE EXTENDED FURNACE

MODERATE SUPERHEAT IS PROVIDED FOR

Equipment on each boiler will consist of Foster superheaters designed to operate under 150 lb. pressure and to give 50 deg. F. superheat, Diamond Power Specialty Corp. soot blowers, Stets feed water regulators, Yarnall-Waring Co. tandem blowoff valves on both the boiler and the water screen, Crane Co. safety valves, Hagan Corp. combustion control system, Bacharach Electric Co_2 recorder, a Bacharach flue gas temperature recorder and Cochrane flow meters on the feed-water lines.

Flue gas, after making three passes through the boiler, will enter a steel breeching at the top of the setting and pass through it to a reinforced concrete chimney which is 8 ft. 6 in. in diameter and 205 ft. high. The breeching is so arranged that two more boilers may be connected in and the chimney is large enough to take this extra load.

Coal, delivered in standard railroad cars, will be dumped into a concrete track hopper. An apron feeder will deliver the coal from the hopper to a crusher from

which the coal will drop by gravity to the boot of a bucket elevator. This elevator will discharge onto a horizontal conveyor which will unload into a tile silo which provides a 70-T. live storage in its upper portion. When the live storage is filled the coal overflows and drops to the bottom of the silo where it can be reclaimed by a conveyor which feeds it to the booth of the bucket elevator. This silo rests on a concrete base which is cone shaped to eliminate dead storage. The silo is 22 ft. in diameter and 55 ft. high, providing a reserve storage of 480 T.

From the live storage the coal is fed by a steel spout to a screw conveyor, which is made with a right hand blade on one half and a left hand blade on the other half, so that the coal will be fed both ways to the small storage hoppers from which the coal will be fed by gravity to the pulverizers. This screw conveyor is motor driven through a Jones spur-gear speed reducer. A magnetic separator will be used to remove tramp iron from the coal. This coal handling system is rated at 25 T. per hr. and it has been designed to take care of four boilers. In the

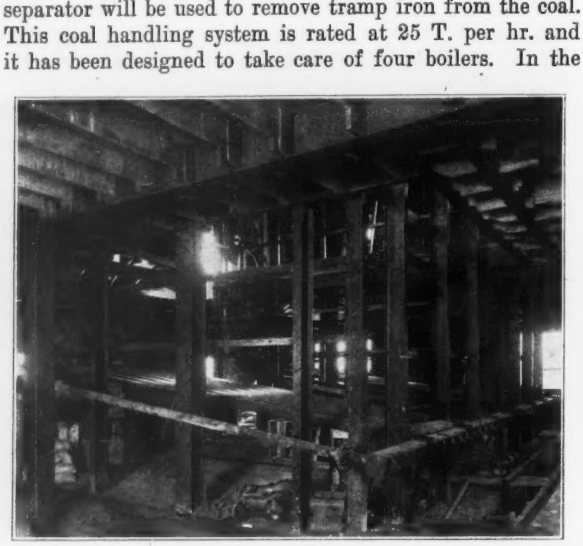


FIG. 2. WATER SCREEN IS TIED WITH THE MUD DRUM AND THE FRONT STEAM DRUM

down spout and just above each pulverizer is located a Bailey Meter Co. coal meter.

Three Raymond unit pulverizers will be used for the two boilers now installed, two being driven by Burke motors and the third or center pulverizer being driven by a Moore steam turbine. The turbine driven unit will be used as a spare and will feed to both furnaces. A single fuel duct leads from each pulverizer to a point above each arch. Here it divides and feeds to the two burners in each setting. The pulverizers are located at the front of the furnace on a floor which is about 12 ft. above the floor which is level with the bottom of the furnaces. This upper floor therefore becomes the operating floor.

For the present two 10 by 6 by 12 in. outside packed plunger pumps will be used to deliver feed water to the boilers. It is probable, however, that they will be changed later to the centrifugal type.

The steam pipe was all fabricated by the National Valve and Manufacturing Co.

Feed water will be treated by an International softener using lime, coal and soda ash. This is a hot process softener and is followed by a sand filter, its rating being 4400 gal. per hr. To provide against an interruption of the water supply from the canal a galvanized steel storage tank of 14,000 gal. capacity will be provided.

The building is of steel and reinforced concrete. The walls are faced with brick on the outside and tile on the inside. The tile surface will be painted. The roof is constructed of corrugated iron covered over with ½ in. of insulating material on top of which is a three-ply composition roofing, mopped on.

The cost of this plant as now planned is $110,000.00, this figure carrying the cost of the coal handling system, water treating plant and the stack, which are large enough for doubling the capacity of the plant. On the basis of rated boiler horsepower this plant will cost, with two boilers, about $130.00 per rated boiler horsepower.

Winter Construction Increasing

AS THE RESULT of a drive undertaken by the construction industries, in co-operation with the Department of Commerce, the building season is gradually being lengthened. This fact has been established through a survey made by the Division of Building and Housing of the Department at the direction of Secretary Hoover to determine what results were being obtained. Reports from contractors in 16 large cities show that payrolls and material purchases were relatively larger in the winter months of 1924 than in those of 1923. The 1923 figures in turn showed an increase over 1922. Payrolls and material bills are measures of building activity which follow actual work very closely.

Figures submitted by a large number of contractors, in answer to the Department's inquiry, showed for each month the percentage of the year's total. Practically all replies had the same trend, making the average a fair statement of conditions. Changes in general business conditions and a difference in the weather undoubtedly had some share in the result. But making allowance for such factors, a distinct increase in the relative amount of winter building is apparent.

There are already favorable indications for the coming winter. The August figures for contracts awarded for all classes of construction have proved to be the highest ever known. Many of the operations represented by these contracts will undoubtedly be carried over into the cold weather.

All groups in the building industry are trying earnestly to bring about a more equal distribution of work throughout the year. Their efforts are bringing results. More and more people are becoming convinced that winter construction is both practical and economical. The growth of this belief is certain to result in steadier employment and more efficient construction service.

THE GENERAL GAS & ELECTRIC CO., New York, operating the Pennsylvania Edison Co., Easton, Pa., and other utility properties, has acquired the plant and system of the Saylorsburg Light & Power Co., Saylorsburg, Pa., and vicinity, and will operate as a part of the Pennsylvania Edison system. The acquired company has a small hydroelectric generating station at Saylor's Lake, and has been purchasing power in blocks from the Pennsylvania Edison Co., for some time past; transmission lines are being built to several neighboring sections, and this work will be continued by the purchasing company, which also plans for extensive additions for increased power facilities in this district.

Power Equipment Developments in Europe

PROGRESSIVE ACTION FRICTION CLUTCH; STIRRUP TESTS; DUST SEPARATORS; TUBE ROLLER; MAGNETIC IRON. BY J. H. BLAKEY

MONSIEUR F. L. Broussouse has recently taken out a French patent for a new form of friction clutch. The special characteristic of this clutch is that the progressive action is obtained by the automatic variation of the coefficient of friction of the surfaces in contact. Referring to Fig. 1, the clutch is arranged within the pulley F and is composed of two groups of disks, connected respectively with the motor and with the transmission to be driven. The hub A of the pulley is keyed to the motor and carries a series of projections B to which are attached the disks C. These disks are set between other disks D, attached by means of projections E to the outer parts of the pulley F and G. Spiral springs H rest upon the outer disk in order to give the necessary friction. Each disk C has upon both faces a series of radial grooves I, spaced evenly on the whole surface of contact (only part of these are shown). The elements F and G of the pulley are tight and leave between them an annular space J, into which oil can be introduced through the opening K. The line MM shows the proper level of the oil when the clutch is at rest.

When the motor is started the oil on the surfaces in contact is thrown off by rotary action and also by the

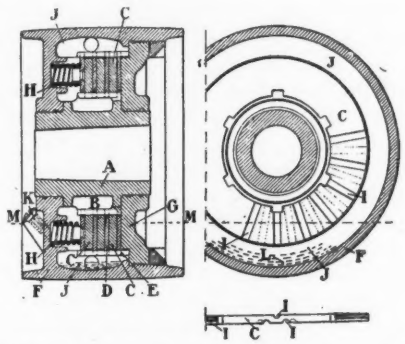


FIG. 1. FRENCH FRICTION CLUTCH WHICH GIVES PROGRESSIVE ACTION

effect of the grooves I, the amount of oil being calculated so that when the pulley revolves there is none in contact with the friction disks. As the rotary action continues the disks become more and more dry and the coefficient of friction between them, which at starting might be represented as 0.01, rises as high as 0.15 or even 0.2. Consequently, given the proper strength in the springs H and disks of suitable size, the progressive action of the clutch continues from a value of 1 to about 15. This clutch has been found satisfactory with alternating current squirrel cage motors; in fact, with any motor which starts at full speed the moment the circuit is closed.

TESTS OF THE RESISTANCE OF STEEL STIRRUPS

The Central Bureau of Normalisation of Delft, Holland, has undertaken a series of rupture tests on steel stirrups such as are of frequent use around power plants. A commission on which are a number of the professors of naval construction of the Technical University of Delft has directed these tests, of which an account is given in the Dutch Review de Ingenieur. The forms of stirrup tested were the harp form and the D form (Figs. 4 and 5). The general dimensions A, B, C, D depend on the size of chains used or of the eyelets of cables. They vary as one makes use of steel or iron cable or of chains. Experience shows that C = about A + B, and that D = about A.

As a result of the tests, the following conclusions were reached: The rupture load for broad D stirrups is about 5.3 per cent higher than for narrow D rings. For the harp form this difference is about 7.7 per cent. This result is peculiar but is probably explained by the fact that the larger radius of the bent part leaves that part stronger than when bent to smaller radius. The tests showed that

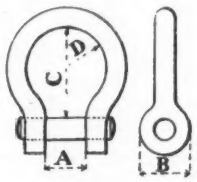


FIG. 2

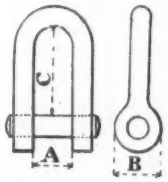


FIG. 3

FIG. 2. HARP FORM OF STIRRUP SUBJECTED TO TEST
FIG. 3. STIRRUP OF THE D FORM

there exists a great difference between the load under which the stirrup is deformed and that under which it breaks. The relation depends largely upon the form of the stirrup and reaches on the average:

For narrow D stirrups	0.31
For wide D stirrups	0.25
For narrow harp stirrups	0.19
For wide harp stirrups	0.14

The allowable load is a fraction of the load causing permanent deformation. The commission estimated that this fraction may be fixed at one half.

The following formula may be used: $W = CED^3 \div (A + D)$ in which E is the limit of elasticity of the steel, D the diameter, A distance between the eyelets and C a variable coefficient. In practice the product CE may have a value 19 for D stirrups and 11 for the harp form, which with E about 30,000 lb. per sq. in. gives for C the values 0.88 and 0.51. The steel must be of the Siemens-Martin type, with a minimum of 22 per cent elongation, and the proportion of sulphur and phosphorus must be less than 0.04 per cent. To find the diameter of the bolt which will give equal resistance to that of the stirrup, make d = 1.2d for D stirrups, and d = 1.1d for the harp form, d and d, being the diameters of the bolt and of the ring respectively.

MANDREL FOR SPREADING THE ENDS OF BOILER TUBES

The German firm of Steinmuller has designed and is using a new appliance for enlarging the ends of boiler tubes. This has been called a "Ball Mandrel" and is described by Professor Berndt in the Zeitschrift des Vereines deutscher Ingenieure for August 2. It consists of a mandrel on which is a cone carrying hardened steel balls; a screw thread on the mandrel causes the cone to advance into the interior of the tube end when the cone is turned. Tests have been made at the technical school at Darm-

stadt which show the superiority of this method over any of the older methods. Tubes of 80 and 95 mm. (3 and 3¾ in.) were tested in plates of 18 and 30 mm. (0.71 and 1.18 in.) in thickness. These tests showed that for tubes not enlarged 11.7 t. was required to tear out the 3-in. tubes and 12.8 t. for the 3¾-in. tubes; with tubes enlarged in the ordinary way, 16.9 and 13.2 t.; with tubes enlarged by the ball mandrel the figures were 24.7 and 33 t. A comparison of the ratio of the power required to tear out the tubes to the resistance to rupture showed the advantage of the new method even more strikingly: the numbers in this case being 1:2, 2:5 and 4:5, respectively.

ANNEALING OF PLATES FOR ELECTRICAL MACHINES

Mons. R. Cazaud has an article on this subject in the Revue de Metallurgie for August. He shows that on account of the great variation of flux in the magnetic circuits set up in electrical machines the plates used in these machines must have the following qualities: 1. High magnetic permeability. 2. A coefficient of hysteresis as small and as constant as possible. 3. High resistivity. 4. Thickness as reduced as the machining operations will permit. These qualities have an influence on the energy losses in the circuits of the machines, losses by hysteresis and by Foucault currents. The author recommends extra soft steel plates having less than 0.1 per cent of carbon, or special plates containing not more than this amount of carbon and 1 to 5 per cent of silicon. It is found that these latter have high resistivity and a very small coefficient of hysteresis and are not subject to "aging" (increase of this coefficient with time). The author has made a number of tests on the effects of different methods of annealing the plates as they come from the rolling mills and has reached the following conclusions: 1. The annealing of plates produces important improvements in their magnetic qualities and therefore must be considered indispensable; 2. The temperature which will give the best permeability and the minimum of losses in the iron is about 800 deg. C. (1470 deg. F.), whatever may be the proportion of silicon; 3. The duration of annealing must be at least 2 hr., but there is no advantage in prolonging the operation beyond 12 hr.; 4. The plates should be cooled in the air.

PROPERTIES OF TYPICAL crude oils from the producing fields of the western hemisphere have been made a study by the Bureau of Mines, Department of Commerce. A report on the subject, just issued, includes comments, tabulated data, and individual analyses of crude petroleums typical of the producing districts of Canada, Mexico, Trinidad, Venezuela, Argentina, Colombia, and Peru. For purposes of comparison, the report also contains analyses of typical crude oils from the largest producing districts of the United States. The Bureau of Mines undertook a study of foreign crude oils for two reasons: First, foreign fields are potential sources of supply for the United States; in fact, considerable quantities of some foreign crudes have already been imported. Second, these oils are very similar in physical and chemical properties to oils found in the United States and a study of these resemblances has scientific value. The results of this survey are contained in Technical Paper 346, by A. J. Kraemer and L. P. Calkin, copies of which may be obtained from the Bureau of Mines, Department of Commerce, Washington, D. C.

Welding on Boilers

INSURANCE, FEDERAL AND STATE REQUIREMENTS SHOULD BE CAREFULLY OBSERVED AND FIRST-CLASS WORK INSISTED ON. BY S. W. MILLER*

IN VIEW of the ever-widening applications of fusion welding throughout industry and the probability that repairs to boilers made in this way will be proposed from time to time, it is well that those responsible for the results should bear several points in mind. For simplicity, these are listed briefly: Most boilers are insured and many boiler insurance policies are so worded that, if repairs are made without the authority of the company carrying the insurance, the policy becomes void. Federal, State and Municipal regulations, as well as those issued by the insurance companies, govern this work.

Only competent welders, used to boiler work, should be allowed to do the welding.

Because of these conditions, the following precautions should be observed by the owner or his representative: Examine the part of the boiler to be welded in company with the insurance company's inspector and get his approval before doing any welding. Be present with the inspector at the test after welding. If possible, get the inspector to sign a statement that the work has been properly done and that it has passed the test successfully.

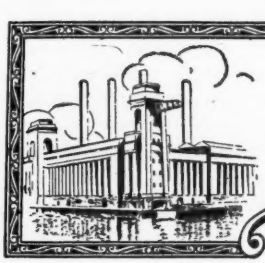
If the boiler is not insured and comes under Federal, State or Municipal supervision, carry out the above program in company with the proper authority. In case of marine work, the welder should pass the regular examination of the Federal Steamboat Inspection Service.

If the boiler is neither insured nor under supervision of some constituted authority, ample precautions should be taken by the welder and the owner to protect themselves against possible future trouble. They should make a sketch of the location and size of the repair, with a clear statement of what was found wrong and how the repair was made. They should always make a hydrostatic hammer test of the finished job, using a pressure of 1.5 times the working boiler pressure, in the presence of witnesses, and get the signatures of these witnesses to a statement of the facts. These papers should be carefully filed away. In any case, no welding should be done which is not permitted by law or by good practice.

In all cases, the welder should make friends of the insurance and other inspectors by refusing to do work unless authorized by them, by being conservative in what work he recommends, and by doing nothing except a first-class job.

*Past President of the American Welding Society.

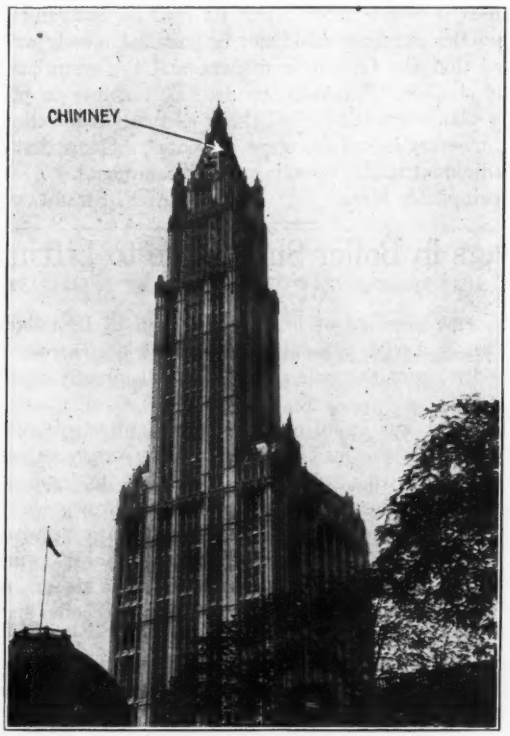
DURING THE PRESENT year more than $5.00 per capita is being spent in the United States by the electric light and power companies of the nation in expanding their systems to meet the increasing demand for greater and better electrical service, according to the employes' magazine of the Louisville Gas & Electric Co. This means a total estimated expenditure of $579,830,000 which completes a total for a five-year cycle in the industry of $2,420,746,000. This year's budgeted expenditure for fuel-burning plants amounts to $168,760,000 and that for hydro-electric plants, $95,750,000. For transmission lines $115,400,000 will be spent and for the distribution systems the expenditure for the year will amount to $199,920,000.



LETTERS DIRECT FROM THE PLANT

World's Highest Chimney Is an Ornamental Tower

In the October 1 issue, page 983, the item on ornamental chimneys causes me to think that readers will be interested to know how this problem is taken care of in the Woolworth Building.



WORLD'S HIGHEST CHIMNEY IS PART OF THE TOWER OF THE WOOLWORTH BUILDING

Close to the top of the main tower at each of the four corners are four smaller ornamental towers, three of which are distinctly visible in the accompanying figure. The spire designated by the arrow, on the northeast corner of the main tower, nearly 900 ft. above Broadway, is the chimney. The gases escaping through this tower have slightly discolored it but from the street this is not noticeable. It is noticeable, however, to visitors in the tower who can look down upon the top of the chimney and who are sometimes considerably annoyed by the gases emanating therefrom.

This chimney, so far as the writer knows, is the highest in the world.

Newark, N. J. W. F. Schaphorst.

Small Turbines Less Economical Than Engines

It is considered by many engineers and others who are interested in the operation of power equipment that the turbine, being more modern than a reciprocating engine, must necessarily be more economical in the use of steam regardless of the conditions under which the equipment is operating. On the contrary the small turbine in sizes below 100 hp. non-condensing has such a high steam consumption that it suffers by comparison with a reciprocating unit, even though the turbine be a modern unit and the reciprocating unit have been in operation for several years.

At one time I had an opportunity to make some tests of both turbine driven auxiliaries and small reciprocating engines and the results were sufficiently conclusive to prove that the use of the small turbine is a step backward rather than an advancement, where the water rate is of any importance.

In one plant I had a turbine of 30 hp. driving the forced draft fan for a battery of 10 boilers and the exhaust was used in the feed heater along with the exhaust of the feed pumps and other auxiliaries. We had several compound condensing engines and had the auxiliary exhaust been insufficient we could have bled the receiver of one of the engines which was lightly loaded or could have used the exhaust of the main condenser pump which was operated condensing, since there would have been an excess of exhaust otherwise. Our feed water was heated in an open heater from 120 deg. to a final temperature of 210 deg. F. and the plant was considered to be economical as far as the existing equipment permitted. We had an old fan which was used only as a spare unit and was over 20 yr. old, a single cylinder engine of the piston valve type of about 30 hp. The chief engineer was insistent that the turbine fan be used as much as possible but I held other opinions as to the feasibility of the plan. When the turbine fan was running the feed temperature was around 210, but with the other fan in service the feed temperature dropped to 198 deg., thus proving that the steam exhausted from this unit was less than with the turbine. Our steam conditions were 150-lb. (gage) pressure, 100 deg. superheat and the average load about 45,000 lb. of steam per hour. A reduction of 12 deg. in feed temperature told us that there was 540,000 B.t.u. less entering the heater and the difference in steam used by the two fans was 540,000 ÷ 970 or 556 lb. per hr. The engine-driven fan indicated 19.6 hp. and of course the other fan developed the same power, both being multi-vane fans with the efficiency assumed to be fairly equal.

To learn just how many heat units the fans were sending to the heater, we piped the fan exhaust to the atmosphere and noted that the feed temperature dropped

to 179 deg. which was equivalent to taking 855,540 heat units away from the heater in addition to the reduction made when changing from the turbine fan to the engine-driven fan. The steam consumption of the engine was then found to be 855,540 ÷ 970 or 882 lb. per hr., and the turbine used 882 plus 556 or 1438 lb. per hr. The steam per horsepower was 45 lb. for the engine and 73 lb. for the turbine, showing that the engine used 38 per cent less steam than the turbine.

The chief argued that since all the turbine exhaust could be condensed in the heater it did not affect the overall economy of the plant, but a little study of conditions in that plant will reveal otherwise. The steam consumption of our condenser pumps was estimated to be around 400 lb. condensing and 500 lb. non-condensing, and by connecting the exhaust of one of them into the heater, we would use 100 lb. more steam per hour for this pump, but could save 456 lb. (556-100) per hour by shutting down the turbine fan.

Permission was finally secured to adopt this plan of operation and the saving of 456 lb. of steam reduced our load by just 1 per cent although the feed temperature was only 208 deg. after the change. Our fuel bill was up to $125,000 per year so that even a 1 per cent saving meant $1250 a year and we figured the net saving at $1000, allowing for the reduction in feed temperature. In view of the fact that this change cost practically nothing, this saving was well worth while. Of course the engine-driven fan was already installed, which was a point in favor of the plan, but if a plant is equipped only with turbine-driven fans it is doubtful whether it would pay to purchase engine-driven fans in order to improve the water rate.

There is also another plant that had a fan driven by a high speed compound engine where the power requirements were 25 hp. for a draft, but owing to a fracture of the crank shaft, the master mechanic recommended the purchase of a turbine fan in preference to buying a new crankshaft for the old unit. The cost of the new shaft was as great as the cost of an entire turbine outfit and the company was on the verge of placing the order, when the chief operating engineer gave them a few figures on the heat balance of the plant.

Part of the load in this plant was carried by condensing engines and part by non-condensing engines in proportion to the demand for exhaust steam. Any desired amount of steam could be supplied to the feed heater by the engines in case the auxiliary exhaust proved insufficient, this being accomplished by shifting the load from the condensing units to the non-condensing units. The water rate of the engine-driven fan was found by the foregoing method to be 31 lb. per hp. and the engineer insisted that the company determine the water rate of the proposed new unit before placing the order. Figures obtained from another of this firm's plants showed that the water rate for their turbine fans was around 70 lb. per hp. or more than double the rate of the old engine-driven unit. The engineer then placed his figures before the management and showed where the operation of the new unit would increase operating costs. Developing 25 hp., the old unit used 775 lb. of steam per hr. and the exhaust was used in the heater, along with part of the exhaust of one of the non-condensing engines.

If the proposed unit was in operation, the steam used would be 1750 lb. per hr. and this amount of steam could be used in the feed heater, but then less steam from the engines would be required in the heater and load would be transferred from the non-condensing engines to the condensing engines which would prove a source of loss for the following reason: The non-condensing units having a steam rate of 23 lb. per hp. would develop 42 hp.

less $\frac{1750 - 775}{23}$ and this much extra load must be carried by the condensing units. The steam rate of the condensing units being 16 lb. per hp., they would use 672 lb. more steam than at present and with a 24-hr. load, the extra steam flow figured 16,128 lb. per day, equivalent to a ton of coal daily. As this involved increased costs of $1800 a year, the management decided to put the old unit in first class operating condition, including a new crankshaft and discarded the idea of buying a turbine fan as there was already a spare unit in the plant, which left no need of the new unit.

Since it could never repay its cost by reducing fuel charges the purchase could not be justified merely on the ground that the turbine is modern and the reciprocating engine obsolete. Naturally, condensing turbines in public utility plants are the logical thing as there is no alternative, but every industrial plant presents problems that call for individual study regarding power equipment.

Springfield, Mass. A. F. SHEEHAN.

Bags in Boiler Shells Due to Lifting of Water

As THE question of bags in the shell of h.r.t. boilers often arises, I wish to mention two cases which were caused by the lifting of the water from the shell directly over the fire.

The first was in an electric light plant where sudden fluctuations in the load often caused the safety valves to blow. At one time, when this was about to happen, to prevent the unpleasant noise, a rope was thrown over the lever (this was before the Massachusetts laws required a pop valve) but it broke before the blow-off point occurred, and when it did it lifted the water with the steam. As a result a bag was made in the bottom and the boiler had to be patched.

In another case, a rubber mill was operated by an engine with quick opening valves; this was once suddenly overloaded by one of the operators throwing too much load in a rubber machine. This caused the water in the boiler to lift with the steam and the result was a bag in the boiler.

In plants where this type of boiler is used, operators should be cautioned never to open a valve too quickly.

Stoughton, Mass. F. E. HUSSEY.

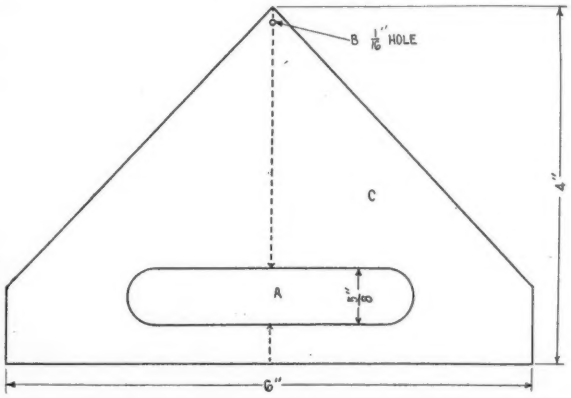
Editor's Note: We have often heard old operators advance this reasoning as one of the causes for bags in boilers, but have never had bona fide verification. It is conceivable that sudden opening of a valve will lift the upper surface of the water from a boiler but it seems doubtful that the entire amount will be lifted at one point. Perhaps some of our readers will furnish further comment.

Plumb-Bob Level Easily Made

ALTHOUGH most engineers have seen carpenters or other mechanics use plumb-bob levels, few realize how easily one of these devices can be made.

The accompanying sketch shows the front elevation of one of these levels. To prevent rusting it is advisable to use a piece of sheet brass of about No. 12 gage. The base should be about 6 in. long and should form a perfectly straight edge. The dotted lines should be cut in the brass exactly perpendicular to the base. This may be done by the careful use of a mechanic's square.

To use the level, a small nut or similar weight is tied to a short piece of string and the other end passed through the hole at B. A knot is then tied in the string behind the plate at B so that the weight will swing in the center of the opening at A. Then when the base of the plate is placed on a surface to be leveled, the top of the plate is



ELEVATION OF SMALL PLUMB-BOB LEVEL MADE FROM SHEET METAL

tipped forward slightly. If the object is level the string will be superimposed exactly on the dotted line.

Probably the most important advantage of this type of level is the fact that there is no glass to break as with spirit-levels. It can be thrown carelessly into a tool box and still be available for use at all times. It is not quite as sensitive as a spirit level but will serve admirably on most jobs where extreme accuracy is not required.

Toronto, Canada. JAMES E. NOBLE.

Objectives for the Station Designer

IN DETERMINING the equipment and layout for a power station, it is but natural to build for the highest overall efficiency which reliability and commercial costs justify. The designer's engineering ability is, to some extent, measured by the relation of the economy theoretically attainable to cost. This feature, however, may result in false standards being thus set up.

There are now many refinements available for improving station efficiency, each of which means an added burden for the operating force. In striving for the utmost in economy, conditions may be introduced that are difficult to comply with. For instance, in order to meet a given change in load with the most efficient combination of equipment, much starting up, shutting down, adjustment of the elements to improve heat balance, etc., may be necessary. A relatively high operating economy is a possible goal which practical conditions may render difficult or impossible of attainment: The designing engineer may be tempted to go to such extremes that the average operating efficiencies will be lower than would obtain in a simpler, more practical plant although of poorer theoretical efficiency.

Another objective for the designing engineer in place of the theoretically attainable efficiency is the degree of efficiency which may reasonably be expected in actual operation. Theoretical efficiency, then, will be less of a factor since the operating result is the real commercial criterion. There is obviously no advantage in a theoretically better installation which will not average as good an economy as a simpler layout although capable under ideal conditions only of poorer results.

In times gone by much was said about economy being given so much prominence in design as to endanger reliability. Nowadays there is little question with regard to reliability but complications, particularly in relation to heat balance, may easily be pushed so far in the interests of theoretical efficiency as to defeat the immediate end in view.

Baltimore, Md. JOHN HARRISON.

Grates Made from Scrap Pipe

METHODS OF utilizing waste or scrap material evolve so rapidly that what was scrap until yesterday has today become valuable. One instrument that has done much for reclaiming metal is the oxy-acetylene blowpipe.

The oxy-acetylene process has rendered scrap pipe valuable for instance. In the back yard of many industrial

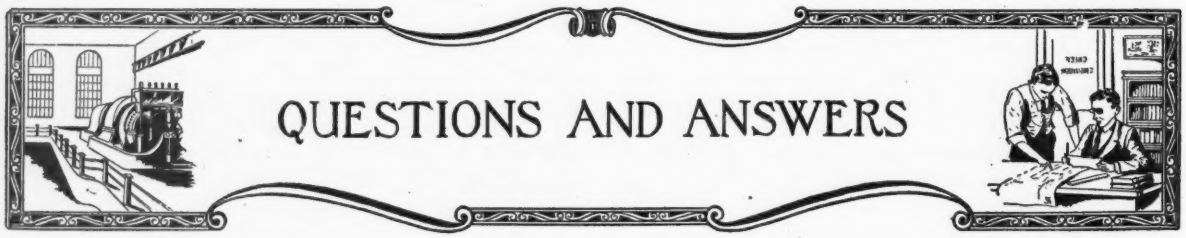
JUNK PIPE AND THE OXY-ACETYLENE TORCH MADE THESE

plants is a junk pile containing pipe in varying sizes and lengths. If needed, more can be obtained at a low price from a scrap dealer.

Recently one large plant had need of a strong fence, with an impressive gateway. They had an ingenious man who saw the connection between a nearby junk pile, the oxy-acetylene blowpipe and the company's need, so sketches were made and work started.

Pipe of the right diameter and proper length was readily made with the cutting blowpipe and by welding short pieces together. When a good supply of usable lengths was on hand, assembling began.

Fence posts were made with U-shaped cuts in the side, leaving a tongue to hold the wire mesh. An attractive gateway was especially desirable so a little more time and thought were spent in its construction. Carefully graded lengths of pipe were welded to a straight supporting cross-beam of heavier pipe; two bent pipe lengths rounded off the top of each large gate, these bends being made after heating the pipe with an oxy-acetylene flame. Then cross sections of large diameter pipe were cut with the blowpipe, and these, welded at intervals along the top of the gates, added greatly to their appearance. Using the same general methods, smaller sidewalk gates were made. Concrete gate posts 3½ ft. square gave an imposing appearance to the entrance which is shown in the illustration.



Sharp Points Contrary to Admission Line Slope

ORDINARILY in the analysis of indicator diagrams, the sharp points *A* at the tops of the admission lines, Figs. 1 and 2, are accompanied by lines which slope backward, or as some state it "lean outward." The leaning outward and

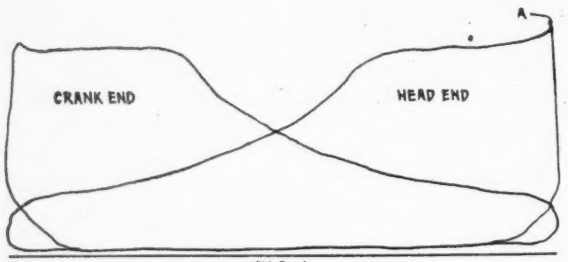


FIG. 1

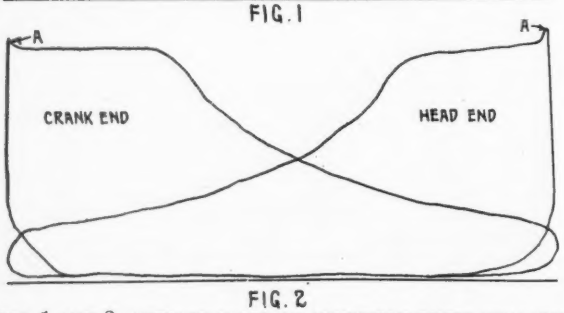


FIG. 2

FIGS. 1 AND 2. INWARD SLOPE OF ADMISSION LINES USUALLY INDICATES LATE ADMISSION. HOOKS AT TOP SEEM CONTRARY

the points at the top are the indications of early admission. But in Figs. 1 and 2 the admission lines lean to the inside, which is an indication of late admission. The inward leaning and the formation of the sharp points at *A* therefore seem to be contradictory and I am anxious for some one to point out a satisfactory explanation. The diagrams are from a 16 by 30 in. double eccentric Corliss engine, speed 150 r.p.m., 60-lb. spring.

Testing the pencil motion of the indicator to determine whether or not it would draw a steam line at right angles to the admission line showed it to be satisfactory.

Burlington, Ia. TOM JONES.

Dry Gas and Ash Pit Losses Are Largest Items

WHEN burning coal by regular methods—pulverized, stokers, or hand-firing—what are the two largest items of loss and how are they calculated? J. S.

A. Heat carried away by the dry gases is the largest item of loss. Unless the coal contains an unusual amount of moisture, the second largest item is the loss due to combustible in the ash pit.

By the dry gases are meant the dry products of combustion such as carbon dioxide and carbon monoxide, also the oxygen and nitrogen in the excess air. Each pound of these gases carries out heat in proportion to the specific heat of the gases and the difference between the temperatures of the gases at exit and the air entering.

Actually there is a different value of specific heat for each of these gases and also the specific heat of each gas varies with the temperature. For practical purposes, in the range of temperatures usually found in boiler practice, and also for all the constituents of flue gas, a value of 0.24 B.t.u. is taken as the mean specific heat.

Loss in B.t.u. $= W \times 0.24\ (T - t)$

Where, W = pounds of dry gas per pound of fuel

T = exit of gas temperature

t = temperature of air entering furnace

W is determined as follows:

$$W = \frac{4CO_2 + O_2 + 700}{3(CO_2 + CO)}\ (C - C_r) \qquad (1)$$

Where C = per cent ultimate carbon in coal, dry basis

C_r = per cent carbon in refuse, dry basis, referred to the dry coal.

Suppose the results of a test gave:

14.0 per cent CO_2

0.2 per cent CO

5.0 per cent O_2

70 deg. F. boiler room temperature

550 deg. F. flue gas temperature, and from analyses of the coal and ash, as received basis, the following values in per cent were given:

COAL

	As Received	Dry
Moisture	4.0	.....
Carbon	75.0	78.0
Hydrogen	4.0	3.7
Oxygen	5.0	1.5
Ash	12.0	12.5
B.t.u.	13,500	14,050

ASH

	As Received	Dry
Moisture	2.0	.....
Combustible	30.0	30.6
Ash	68.0	69.4

As shown by the analysis, a pound of dry coal contained 0.78 lb. carbon, but in the process of combustion not all of this carbon was converted into flue gas since the refuse in the ash pit held 30.6 per cent combustible. If the refuse was not weighed in order to calculate its value in terms of the dry coal, it may be shown that since the dry refuse contained 69.4 per cent ash then there was 1 ÷ 69.4 or 1.73 per cent refuse for each 1 per cent ash in the coal. With dry coal of 12.5 per cent ash, the refuse amounted to 21.6 per cent. Then the weight of carbon in the refuse, as a fraction of a pound of the dry coal is:

$$0.216 \times 0.306 = 0.066 \text{ lb. carbon} = C_r$$

$$W = \frac{56.0 + 5.0 + 700}{42 + 0.6} \times (0.78 - 0.066) = 12.75 \text{ lb.}$$

Loss n B.t.u. per pound dry coal $= 12.75 \times 0.24 (550 - 70) = 1470.$

$$\text{Loss in per cent} = \frac{1470}{14050} = 10.5$$

It is desired that readers particularly note the fact that in many handbooks, formulas for obtaining the weight of dry gas per pound of carbon are given as being multiplied merely by C to obtain the weight per pound of dry fuel, C being the per cent of carbon in one pound of the dry fuel which is *actually burned*. This leads to confusion and in many cases the value for the ultimate carbon in the dry fuel is used for C rather than letting C represent the amount of carbon actually burned, which is found by subtracting the carbon in the ash (as a fraction of 1 lb. of dry fuel) from the per cent of ultimate carbon. It therefore makes the problem much clearer to use the expression $(C - C_r)$ as stated in formula (1). It is also important to refer all calculations to a dry basis. The calculations of test engineers are frequently wrong, due to their failure to consider this point.

If the refuse had been weighed, the loss to combustible in it could be figured as follows:

$$\text{Loss in B.t.u.} = C \times R \times 14{,}600 \qquad (2)$$

Where C = per cent carbon in the refuse, dry basis
R = dry refuse, per cent of dry coal.

In the foregoing problem where no weight of the refuse was taken, the amount of dry refuse in per cent of dry coal is calculated as previously shown and the loss is obtained by the following formula:

$$\text{Loss in B.t.u.} = \frac{C \times A}{1 - C} \times 14{,}600 \qquad (3)$$

Where C = per cent carbon in the refuse, dry basis
A = per cent true ash in the dry coal
14,600 = heat value of 1 lb. carbon.

Substituting the values previously given:

$$\text{Loss in B.t.u.} = \frac{0.306 \times 12.5}{1 - 0.306} \times 14{,}600 = 805$$

$$\text{Loss in per cent} = \frac{805}{14050} = 5.74$$

Confusion seems to be caused by misunderstanding of the terms ash and refuse. By ash is meant the per cent of true ash in the dry coal by proximate analysis. By refuse is meant the amount of material, including true ash and unconsumed carbon, removed from the ash pit during the test.

If the refuse has been weighed, formula (2) is to be used, otherwise formula (3) must be used.

Starting Stoker Fire with Gas

CAN YOU recommend some other scheme to start a fire on a chain grate stoker besides using a lot of wood and oily waste? In our plant, where we have a large number of these stokers, wood suitable for this purpose is hard to obtain and is often too wet to burn. A. R.

A. In plants where gas is available the coal on the stoker may be ignited in a few minutes by means of a gas flame played over the surface of the fuel bed. A sheet of flame is spread out over the entire width of the stoker by using a burner made of perforated pipe, as shown in Fig. 1. Holes are provided in the pipe along one side only, this side being directed toward the inside of the furnace.

One arrangement, as found in a large plant where there are a number of chain grate stokers, provides for gas line connections in front of each boiler. The rubber hose attached to the burner, as shown in Fig. 1, is about 10 ft. long and provided on the end with a standard threaded hose connection. When starting fires, the burner can be carried from one stoker to the next.

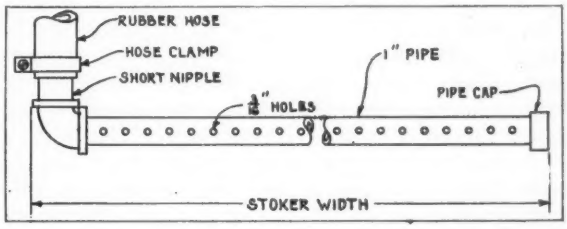


FIG. 1. GAS BURNER MADE OF PERFORATED PIPE FOR STARTING FIRE ON A CHAIN GRATE STOKER HAS FLEXIBLE HOSE CONNECTION

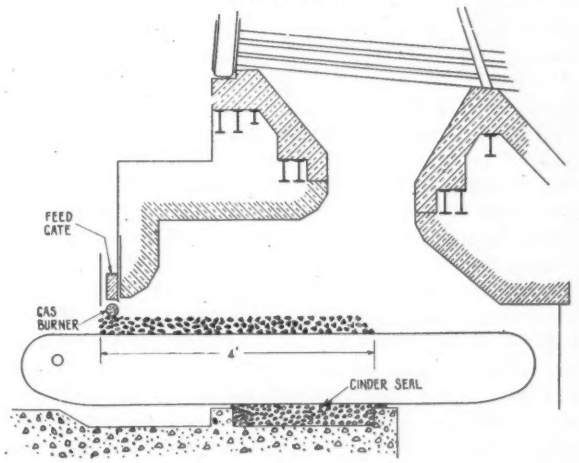


FIG. 2. CHAIN GRATE STOKER HAS COAL RUN IN ABOUT 4 FT. AND GAS BURNER FOR STARTING IS PLACED DIRECTLY UNDERNEATH FEED GATE

The method of starting a fire is similar to starting with wood. Raise the feed gate to a height of about 4 in. above the grate and then run in coal for a distance of about 4 ft. If there is any fuel oil or gas oil available, splash a little on the coal from time to time as it is being run in. Next, raise the feed gate about 2 in. above the fuel bed and lay the gas burner across the width of the stoker, on top of the fuel bed, just underneath the feed gate, as shown in Fig. 2.

After attaching the hose to the gas line, turn on the gas and quickly light it, first having opened the flue damper so there is 0.10 to 0.15 in. water draft in the furnace. This draft will then draw a solid sheet of flame over the coal and ignition will be effected in about 5 min.

If there is no oil available to throw on the coal, it can be ignited with the gas alone, but of course a slightly longer time will be required and a little more gas will be needed.

As soon as the coal is well ignited, shut off the gas, remove the burner, set the feed gate to the desired height and then seal the front with coal as quickly as possible.

EDITORIAL COMMENT

Theories Made Into Facts

Although it is impossible to predict with certainty just what progress will be made in any industrial field, a review of what has happened in the recent past will point to the places where particular effort has been made and where progress is needed to keep the departments well balanced.

During the past year marked advancement has been made along several lines in the power generation and distribution fields. Scarcely two years ago, much that we may see today as an accomplished physical fact was theory, existing only in the minds of our leading engineers and recorded in their writings. The use of high pressure and high temperature steam as we see it today in recently built plants has been proved practicable; regenerative and reheating cycles are being employed with positive assurance as to results to be obtained; automatic combustion control has reached a high degree of perfection; furnaces have been greatly reduced in size; interconnection of power plants in a number of districts has permitted the operation of extremely economical base load stations; much has been done toward serving the farms of the country with central station power; the field of the Diesel engine is becoming more definitely established.

Who is it that can say what the next move towards more economical generation and wider use of power will be? By getting, however, a general perspective of the entire situation, such as has been the endeavor to give in this issue, some idea may be obtained of the tendencies of the times and how these new developments may be used to advantage in the solution of individual problems confronting power plant engineers.

Knowledge Just Around the Corner

If someone were to tell you that just around the corner there was a great school, where all the knowledge of the earth could be yours just for the asking, would you take advantage of it? Would you go out of your way to get a good education for nothing?

Shakespeare once said that there are "sermons in stones and good in everything." Even then he was prophesying the sciences of modern geology and paleontology. But stones are not the only apparently innocuous things in which sermons or other educational lessons may be learned.

Within easy reach of his hand, the average power plant operator has a wealth of knowledge often overlooked or, at best, neglected. Manufacturers, who supplied the equipment for the plant, may have flooded the place with their catalogs and bulletins and yet, just around the corner of the boiler room, in the dingy office, they lie in a disordered heap, forgotten. The operator wonders what good they are and dismisses them with the thought that most of the stuff is propaganda anyway.

Therein he makes a grave mistake. These catalogs are more than mere "ads." They are actually scientific treatises on boilers, pumps, stokers, condensers and the numerous other pieces of apparatus which go to make up the modern power plant.

Today, manufacturers are selling their equipment on its merits and on its record of service. Their methods of design and operation are based on sound engineering principles backed by reliable experimental data.

It is not only logical, therefore, that their advertisements, appearing in the leading technical journals, should be authentic but that the data published in their catalogs and bulletins should be accepted as the nuclei for the leading textbooks on power plant practice.

A veritable gold mine of useful information is crowded into advertising covering the power plant field. Don't neglect the advertising pages of your technical paper and be sure you have the latest catalogs and bulletins on all of your plant equipment.

Knowledge is yours for the asking. It is even closer than just around the corner. The mail man will bring it to you.

Taxes Cost More Than Food

Recent United States Census reports bring to light the fact that in many of our cities the cost of government exceeds the cost of food. This is not altogether surprising when we recall the mania for voting bonds which swept over the country a few years ago, actually tripling state and local taxes in the decade beginning with the war. There is, however, a coincidence revealed by a study of the figures given by the government which is of extreme interest to those who have been watching the trend of power plant ownership. This coincidence is that in the large cities of the country the highest cost of living is noted where municipal ownership of utilities has a strong hold, and the lowest in the cities where no municipal ownership of utilities exists.

Figures are not available in all instances to show whether or not the municipally owned utilities are actually running at a profit and it would, therefore, be unfair to say that these utilities have caused the living costs to go up. More than likely the same spirit in a community which has forced municipal ownership upon a city has loaded upon the tax payers many other burdens, such as street paving, boulevards, parks, beaches, piers, schools and numerous other undertakings which come under the head of improvements but in many instances are far more expensive and elaborate than the city can well afford.

Such conditions are likely to exist in communities where voters who are not taxpayers have the mistaken notion that in passing a bond issue the burden of paying for the community development will not fall upon them but upon the property owners, little realizing that the property owners must charge higher rents to make their investments profitable and these are reflected in higher living costs all along the line.

The community that owns a power plant and operates it at a loss places a burden upon each individual just as surely as though he were a stockholder in a company that was losing money. On the other hand, a money making municipally owned plant is supposed to pay dividends by reducing taxes. Usually, however, if these dividends are not taken to pay for other municipal undertakings, the rates are reduced to the no-profit stage and only the users of the utility's service benefit; the average citizen who is paying for the project in higher living costs gets little or no benefit from his investment.

Comparison of the census figures recently made public shows a variation in living costs in various cities, from 84.8 to 123.8 per cent of the country's average, with the municipal ownership cities in the high ranks.

Off Duty

Somehow or other it seems strange, almost paradoxical, in fact, that engineers as a whole are rather an unimaginative, matter of fact crowd. Dealing with the materials and forces of nature, as they do, it would seem that they might absorb some of the romance, some of that sense of the unexpected which lurks around the corners of nature's hiding places and which is encountered whenever her methods are investigated. But they do not—understand, here I am speaking of engineers in the collective sense and am not referring to the brilliant exceptions which prove the rule. Romance is as far removed from the average engineer's makeup as a knowledge of dietetics is to a Hottentot. His indifference to modern scientific thought is bewildering.

Too many engineers take life too seriously. They overestimate their responsibilities and are too much slaves to the rigid laws and formulas on which engineering is based. This is reflected in the way they express themselves. When, for instance, an engineer wishes to convey the idea that the circulating water at his plant is dirty, he comes out with the amazing assertion that the water contains an excess of suspended matter! When he wants a tell people that the smoke goes up the chimney, does he say so? No, indeed, instead, he tries to disguise the fact behind the pedantic statement. "Removal of the gases of combustion is effected through the agency of a radial brick stack." When he wants to know whether the steam going into an engine contains any water, he springs the enigmatic query, "What is the quality of the steam?" Again, when he wants to impress you with the fact that a pipe line contains a vacuum, he refers to it as carrying a negative pressure! Negative pressure! Now, what on earth is negative pressure? More logical is the darky coal passer's definition, who said that a vacuum is something that goes P s s s - s - s. However, there is absolutely no harm in the engineer's use of such high-sounding phraseology and if the term "negative pressure" tickles his vanity, by all means let him use it. That is a matter apart from the subject under discussion.

The average engineer, we believe, would not consider himself an artist. Art, he claims, is something separate, in fact, the exact opposite of science and engineering, and has nothing to do with it. Yet in a book, "The Dance of Life," Havelock Ellis shows that art and science are based on the same human impulse and that there exists no such distinction between them. For what is the engineer but a builder? Whether it is a statue in marble, or a library, or a ship, or an engine, one is building, it makes no difference. Each one of these things is an expression, so to speak, of certain ideas in the mind of the builder. The marble statue, fashioned by the hand of the artist, is purely a product of the artist's imagination. But is that not also true of the ship or the engine? What was the steam engine but a product of Watt's imagination? Before Watt, no one had ever thought of a steam engine as Watt conceived it and when he fashioned a quantity of iron into an engine, he put form to his imagination in the same way that the sculptor puts form to his ideas in clay or marble.

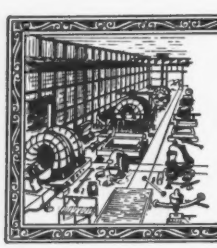
Imagination is just as much an essential quality of an engineer's mind as it is of an artist's and only those engineers who possess this quality of mind can expect to rise to the greatest heights of engineering achievement. Too many engineers regard the proper packing of a pump as an engineering accomplishment when, as a matter of fact, it is nothing of the sort; it is merely a routine job for a skilled tradesman. It is this so-called "practical attitude" that explains the average engineer's indifference towards science.

In answer to this charge of lack of scientific interest, the engineer will claim no doubt that if this is so, which, of course, he is not at all ready to admit, but supposing it is so, it is because science is advancing too rapidly and that he has no time to keep up with it. But that is a poor excuse. Those who possess even the remotest instincts of that sheer love of science, which makes Faradays and Steinmetzs, will *find* time—no matter how busy they may be in keeping the wolf off the premises.

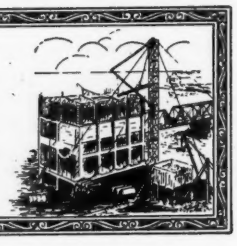
That instinctive love of science, which enabled that grand old man, John Brashear, to start all over again after the telescopic lens, on which he had worked two years, cracked, knows no discouragement. It cannot be put off and, it seems to me, the man who remains indifferent to the wonders and marvels of nature, which science is revealing day by day, lacks the very nucleus around which his engineering mind should be formed.

From this it must not be inferred that every engineer should be a Michelson, a Millikan or a Langmuir; that would be absurd. The great discoveries in science throughout all ages must always go to those great geniuses who arise out of the masses of humanity but once in a hundred million times. Nature is not so generous that she is willing to give up her secrets to any Tom, Dick and Harry possessing a smattering of scientific knowledge. But that should not be a discouragement. When we go into a theater, the fact that we cannot all be actors does not detract from our enjoyment of the play. These wizards of science, Millikan, Michelson and Langmiur, are the actors in the great drama of science; we are the audience. The question is, cannot the audience display a little of the interest in the play that the actors do themselves?

IN AN ADDRESS delivered before the New England Conference of Governors, at Worcester, on Nov. 12, Owen D. Young, Chairman of the Board of Directors of the General Electric Co., discussed in detail, the effect of power upon the economic condition of the country. "One eminent authority," said Mr. Young, "states that the higher wages in this country are due to the twenty-nine million horsepower established in our factories; which is the equivalent of two hundred and ninety million workers. Or to put it more dramatically, each of our workers is in a position to command the power of thirty-three slaves. Athens had but four for each individual."



POWER PLANT ENGINEERING DEVELOPMENTS AND NEWS



Power and Industrial Problems

AT THE ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, OIL AND GAS POWER, INDUSTRIAL POWER, MACHINE SHOP AND WOOD INDUSTRIES PRACTICE, DESIGN AND TESTING, STEAM TABLES RESEARCH AND PLANT MANAGEMENT WERE SOME OF THE SUBJECTS DISCUSSED

OPENING on Monday with registration, Council and committee meetings and an open house gathering in the evening, the Annual Meeting moved forward to a satisfactory and beneficial four days of busy sessions and cheerful social gatherings.

For Tuesday morning, the visitor must choose between four sessions, all interesting to power plant engineers,—oil and gas power, of course,—transmission by belts in the machine shop session, high-speed induction motors in the wood industries, a meeting on test codes for steam turbines. So we are trying to choose those of greatest interest.

In the Oil and Gas Power, two papers were of major interest. One, "Blast-Furnace Gas Engines at Maryland Point," by A. A. Raymond, and another, "Centrifugal Compressors for Diesel Engines," by Sanford A. Moss.

Wood Industries was largely on details of special processes but valuable data was presented on special motors.

In the Machine Shop session, Professor C. A. Norman of Ohio State University gave the results of some analyses of past tests on belt transmission of power and results of tests which he has made as to the effect of slip on power transmitted. Past tests do not seem to have taken this feature into account. He found that on cast-iron pulleys the power transmitted tends to increase with the slip, within limits; this effect was found with rubber, balata and impregnated textile belts, but was especially marked for certain mineral-tanned leather belts and for oak-tanned which had been run for a period. Rubber and balata reach a maximum beyond which increase of slip gives no added power. Tension need not be increased to get this effect; the greatest per cent of tension turned into effective power was found with mineral-tanned and run-in, oak-tanned leather belts, but it is high for balata and for rubber and impregnated textile belts exceeds 60 to 70 per cent. New oak leather belting is less, but rubber, balata and some textile belts give full service from the start.

In discussion of this paper, Robert W. Drake of the International Harvester Co. stated that, in some 20 per cent of drives investigated, the starting conditions should govern the design. For instance, cold buildings for starting on Monday morning with oil stiff in the bearings; machines with heavy starting inertia such as grinders, shears and coal crushers. Many drives have a starting load or short period peaks twice the average running load and must care for these extremes. Experience shows that drives will run for 5 to 20 sec. with tension difference between tight and loose sides twice that for which the drive was designed, without the belts jumping off the pulleys or being burned.

HIGH-SPEED, HIGH-FREQUENCY MOTORS

Direct motor drive for high-speed machinery, especially that used in wood-working establishments, is causing a demand for induction motors to run at speed higher than can be had from the usual 25- and 60-cycle commercial circuits. For a 2-pole motor, the synchronous speed on a 25-cycle supply is 1500 r.p.m. and on a 60-cycle, 3600 r.p.m. but rotors of the drawn shell type can run mechanically up to 30,000 r.p.m. in smaller sizes and there is call for speeds up to 12,000 r.p.m. For larger sizes, speeds up to 7200 r.p.m. are desired.

Characteristics of motors to meet these requirements were discussed by Charles Fair of Baxter D. Whitney & Son, Inc.

Special applications to wood-working machines were illustrated and described and wiring diagram given for a typical system.

In commenting on Mr. Fair's paper, Fraser Jeffrey, of the Allis-Chalmers Mfg. Co. said that cost of frequency changers is a considerable factor in the expense of high-speed motor systems and choice of equipment can affect this factor materially. In a 120-cycle system, a 4-pole motor and generator for 1800 r.p.m. will cost less than an 8-pole for 900 r.p.m., but a 2-pole at 3600 r.p.m. may not cost less than a 4-pole. In general, however, the lower the speed, the higher the cost. Frequency can be varied by using various combinations of poles in motor and generator, but it is to be remembered that, with squirrel-cage motor, the speed will drop with increase of load and so lower the frequency and capacity of the generator.

Also, as a system grows, if frequency changers are added to increase capacity, it is difficult to keep them in step. The squirrel-cage motors must run at precisely the same speed, a thing difficult to achieve. It may require slip-ring motors with external secondary resistance and, even then, it is not easy to hold speeds exactly together. A better way is to split the system into groups, each having its own frequency changer.

Power Test Codes for Turbines will be discussed in a later issue.

Papers on Tuesday afternoon at the Industrial Power session were of such interest that they will be abstracted at length when greater space is available.

Two papers on centrifugal compressors presented special aspects of this class of equipment.

Heat Balance Method for Testing Centrifugal Compressors

In this paper, M. G. Robinson presented a proposal for overcoming the difficulty of measuring the power furnished to a turbine-driven compressor. Energy so furnished is used in compressing the air, delivered to cooling water, wasted by radiation and convection to surrounding air, lost in friction and carried away by air leakage. By measuring temperature and pressure rise and volume of flow for the air and cooling water, the heat energy delivered to them can be evaluated. Losses from radiation, friction and leakage run from ½ to 2 per cent each, hence need not be established with great precision for at or near full load. At partial loads, inaccuracy in these items, which are difficult to measure, may introduce errors but probably not greater than those liable to occur in measuring the output of drivers at light loads.

Methods are given for determining the energy delivered to air and water from measurement of heat effects; also test data, the apparatus used and method of getting readings and working them up to final results. Formulas needed are given and explained with full test data and results for several compressors in an appendix.

Comparison of the heat balance method with determination of input from drivers of known efficiency showed agreement within 2 per cent. At 80 per cent load or over, the author feels that satisfactory results can be obtained. For lighter loads, the degree of accuracy will depend on the engineer's ability to determine closely the losses.

Centrifugal Compression for Refrigerating Plants

By mathematical analysis, W. H. Carrier showed that the centrifugal compressor, which acts on the same principle as a centrifugal pump, must have a proper angle of blade at the inlet to the impeller, if it is to give best efficiency. Also that the shape of the passage through the blades will have no effect on action except as to friction losses. For converting velocity head into pressure head at the outlet of the impeller, a series of diverging nozzles, a free vortex ring or a single continuous diverging nozzle may be used. The first named has some advantages, especially for compound compressors but power required for driving the impeller will be the same for all three methods.

With this type of compressor, Mr. Carrier showed that the compression ratio and condenser temperature remained nearly steady over a considerable range of volume delivered but beyond the overload point falls off, at first gradually, then rapidly. Horsepower increases with the load, although not in exact proportion up to the heavy overload drop. Beyond that point, the horsepower falls off slightly, thus preventing overloading the driving motor.

Wide variation in the ratio of compression can be used by varying the temperature of the condensing water without overloading the motor. Condenser water can be shut off entirely, yet the pressure will not rise unduly, since the ratio of compression will fall off slightly at loads below rating. This makes operation fool-proof without special relief valves and makes it possible to regulate output and temperature by controlling the quantity of condensing water.

Operating at a constant speed the horsepower for rotors with radial outer blade tips will vary in straight line relationship with the weight of gas handled but this straight line will be different for each average density of gas. Friction and leakage losses are constant at all loads but eddy or churning losses increase as the load decreases.

Hon. Herbert Hoover Speaks and Is Made Honorary Member

At the Henry R. Towne lecture on Tuesday afternoon, Secretary of Commerce, Herbert Hoover, emphasized the need of research in pure science if continued progress in industrial research and in engineering practice is to be maintained. We must build up knowledge grain by grain and the discovery of a new law of nature is more important and far-reaching in results than any improvement in a machine or a process.

Rewards for pure science workers are now so inadequate that industrial research is depleting their ranks and there is great need for larger support for university men so that their number may be increased and more time allowed for research; for co-ordinating investigations which, though narrow in scope, may call for co-operation of many workers and large expenditure; for aiding pure science institutions such as the Smithsonian that they may have larger staffs, better equipment and an adequate force of assistants and clerical aid to conserve the time of gifted investigators.

Men like Faraday and Millikan have a value beyond price and ask only opportunity to live and work. Money cannot buy genius but genius has to eat. This country is behind most of those in Europe in developing investigators because we do not offer opportunity. We spend on pure research one-tenth what we pay for cosmetics. We take pride in our practicability. May it not be a very practical thing to give adequate organized financial support to pure science research and thus develop contributions to abstract knowledge on which industrial progress largely depends?

At the Tuesday evening meeting, Secretary Hoover and Worcester R. Warner, past president of the Society, were awarded honorary memberships for distinguished service to society and to the profession of engineering.

Wednesday was taken up with machine design, shop management industrial furnace problems, with business meetings, education and training and the annual dinner. The last was the usual success and is a notable addition to the enjoyable features of the meeting.

Progress in Oil Engines

Reports on various branches were made by the several professional divisions at the Wednesday general session, and those pertaining to power development are abstracted herewith.

For oil engines, capacities have increased rapidly, two engines of 7500 hp. each at 115 r.p.m. having been installed in the Asturias at Belfast and a 15,000-hp., 9-cylinder, 2-stroke-cycle, double-acting engine now being under construction for a power plant in Hamburg. The Asturias engines are 4-stroke, double-acting with 8 cylinders 33 by 59 in.; total height 36 ft., length 60 ft. and weight 700 t.

These and 18 Diesels of 2700 to 3000 brake horsepower for the U. S. Shipping Board show the trend toward double-acting units.

Nordberg engines of 3750 hp. for the Panama Canal Zone, 2-stroke, single-acting with 6 cylinders 29 by 44 in.

at 125 r.p.m. are the largest yet built in this country. McIntosh & Seymour have furnished two 800-hp. and two 900-hp. Diesels to drive electric generators for dredge work, the pumps being driven by electric motors.

Marine application is increasing. For June, 1925, Lloyd's Register showed 323 reciprocating engines of 559,970 hp. under construction, 34 steam turbines of 353,144 hp. and 284 oil engines of 808,264 hp. For August, 1925, total marine oil-engine horsepower under construction was 918,000 hp., of which 48 per cent was 4-stroke and 23 per cent 2-stroke single-acting, 23 per cent 4-stroke and 6 per cent 2-stroke double-acting. In locomotive application, a 1000-hp. engine has been completed by the Baldwin Locomotive Works and in Germany two 1200-hp. locomotives, each with 6 cylinders 17¾-in. diam. by 16½-in. stroke, have been built to run at 450 r.p.m. One has electric, the other gear transmission. An interesting novelty under construction is a Diesel engine driving an air compressor whose output is heated by the engine exhaust and then used in ordinary type locomotive cylinders.

Solid injection is gaining in favor, both in number of makers and in size of units, the De La Vergne Machine Co. having a 1000-hp., 6-cylinder engine, 21- by 30-in. cylinders.

Supercharging increases power from 10 to as high as 30 per cent and decreases cost, as well as providing reserve power for peak loads. Independent centrifugal compressors are widely used for this purpose.

Softening of jacket water with cooling and re-use is being followed in many cases and has overcome cracking of cylinder heads due to scale formation.

Centrifugal purification of fuel oil, air filtering, measurement of exhaust gas temperatures to check distribution of load on multi-cylinder engines and utilization of exhaust heat are being tried out.

Use of Fuels

Increasingly, the boiler room has become a laboratory of steam generation. Automatic regulation is progressing and promises to approach that for steam-using apparatus.

Combustion space needed in powdered-coal furnaces has been greatly reduced by methods of agitating the envelopes of inert products about the coal particles, thus accelerating combustion. Tendency is to use water-cooled walls to eliminate troubles with refractories and to preheat air for combustion. Pulverized fuel appears to have advantages in handling poorer and cheaper grades of coal.

Interest is sustained in processing fuels but no installations of low-temperature plants have been made on a commercial scale. Conversion of coal into liquid fuels is being investigated, a German plant being reported under construction for treating 200,000 t. a year by subjecting powdered coal held in oil to high temperature and pressures, agitating in an atmosphere of hydrogen and thus rendering 10 to 45 per cent of the coal soluble. The asphalt-like product, after removing the carrying oil, can be further partly reduced to motor fuel.

Study of furnace conditions which cause clinkering and failure of refractories are being studied with the object of permitting the use of higher furnace temperatures, less excess air and more efficient combustion.

Centralization of steam power production has continued, units of 50,000 and 60,000 kw. having been put in operation and one of 70,000 kw. ordered. 100,000 kw. units are being discussed.

Bleeding and stage heating of feed water have somewhat reduced the steam to be condensed per kilowatt generated, but condensers have increased to 70,000 and 80,000 sq. ft. of surface with corresponding enormous requirements for condensing water.

Bleeder heating of feed water has resulted in heat savings and reduced the work left for economizers so that these are being reduced in size and flue gas heat utilized for preheating combustion air.

Preparation of coal in pulverized fuel plants is getting more attention, mills having increased in capacity with decrease in power consumption per ton of output. Drying is now by flue gases or by steam bled from the main turbines. Burners are working toward air and coal mixed in proper proportions before entering the furnace, giving shorter flame and allowing decrease of furnace volume. Use of the unit system of preparation is increasing in the smaller plants but separate preparation is universal for large stations.

To increase life of furnace walls, hollow air-cooled construction and water cooling by tubes connected to the boiler circulating system are being used.

Automatic combustion control to regulate operation in accordance with demand for steam and to proportion fuel and air supplies for greatest efficiency is rapidly developing.

For standard design, 400 lb. seems to be the limit of pressure, but 600 lb. with reheat of steam during expansion has been employed in at least 3 stations. In Weymouth station a double pressure system is used, one boiler and turbine operating at 1200 lb. and exhausting at 375 lb., the pressure at which the main portion operates, this exhaust being reheated before discharging into the main steam system.

Boiler drum walls are 4½ in. thick and special care with X-ray examination of all steel castings being used. This pioneer work is being watched closely as its success will mean a new method of raising the heat range of low and medium pressure plants.

Study of standards is being made for piping, valves and fittings for pressures up to 1500 lb. and of materials suitable for temperatures above 725 deg. F. so as to increase the possible working range of steam pressures and gain economies in power generation.

A pound of coal per kilowatt-hour is no longer a fanciful slogan but attainment seems to be in sight.

In the discussion on High Pressures, emphasis was placed by J. R. McDermet of the Elliot Co. and by Dr. R. E. Hall of the U. S. Bureau of Mines on the need for careful handling of feed water when using high pressures. Sodium carbonate is dangerous in high-pressure boilers and difficult to remove so that it will not precipitate. It comes down at the hottest part which is the worst place for it to accumulate. Also, the quieter and slower circulation which is permissible in high-pressure boilers, while an advantage with pure water, is undesirable with sodium sulphate present as it gives a greater opportunity for settling out at the hottest point.

Mr. McDermet considered that, on account of cost and heat required, it is impracticable to evaporate over 25 per cent of the boiler feed supply.

Dr. Hall stated that the remedy for scale formation was to make conditions such that adherent substances cannot be deposited. For low pressures and ratings this can be done by soda ash and lime treatment or by base

exchange but for the high pressures discussed by Mr. Ryan this cannot be done. The concentration of sodium carbonate must be reduced and blowing down is not sufficient. Sodium phosphate treatment is good but costly and for small amounts of make-up water evaporation is a good method.

For large amounts of make-up it is possible to use: (a) primary treatment with lime and soda ash or a base-exchange process followed by maintenance of sodium phosphate concentration; (b) primary treatment with barium carbonate followed by phosphate concentration control. In maintaining proper concentration it is essential to test the boiler water itself.

W. G. Diman of the Amoskeag Mfg. Co. emphasized the importance of studying the use of steam for process work. If all the steam needed to develop power is also needed for industrial processes and heating, there is no advantage in going to higher pressures. If study shows that steam is used wastefully in the process work, reduction of this waste may give an excess of power steam and high pressure should then be considered.

Overhead must be watched, however, and the cost of valves, water columns and minor parts increases greatly for high pressures. Average pressure today, for central stations, is about 350 lb.; for industrial plants, about 200 lb., with temperatures about 200 deg. higher for central stations than for industrial plants.

Thursday was again a busy day for the man interested in power plants. The four papers presented at the steam power session were of such interest that they must be held over for longer abstract than could be given here; Recent Developments at Colfax Station by Charles W. E. Clarke; Boiler Furnace Radiation by B. N. Broido; Steam Bleeding and Turbine Performance by C. D. Zimmerman; Development of a Unit Pulverizer by R. Sanford Riley.

Other sessions of Thursday were largely on special branches of engineering but one paper in the management session touched on plant design.

Plant Design and Plant Efficiency

In his paper on this subject, Harold T. Moore of Day & Zimmermann, Inc., Philadelphia, discussed the factors which enter into plant design: best selection for an industrial site to get materials, labor, transportation and power; type of buildings and arrangement to fit the manufacturing schedule; plant capacity and future growth. Factors which apply to power plant design are the same except that the load to be supplied is often a controlling element.

By studying the largest probable ultimate growth, planning for it and then working backwards to present and immediate future needs, the first installation can be intelligently planned and future enlargement will involve least expense. Plans should contemplate step by step enlargement with provision for probable changes due to progress in practice.

Co-operation of designers and operating management is needed to insure that all necessary facilities for production, sanitation and safety will best meet the requirements. Good light and architectural attractiveness should have careful consideration.

Bolts in power plants may not be considered longer as bolts, but should be reckoned with as important factors in safety and dependability of the system.

Since the coming of high and higher pressures—400, 600, even 1200 lb.—into power plants, it has been necessary to watch with increased care every detail that affects reliability and safety. Piping systems must be secure and, as a system is no stronger than its weakest point, we cannot afford to overlook the bolts which hold the whole system together.

Professor William P. Wood of the University of Michigan presented in this paper some results of tests and photomicographs of the metal structure of bolts and nuts delivered for pipe-line construction. The tests showed that the wrought iron bolts were often below proper tensile strength and elastic limit and that the structure was not uniform as streaks of slag were shown at various points as well as fiber distortion, apparently due to cold working of the metal.

Vibration of Steam Turbine Buckets

Wilfred Campbell, who died in July, 1924, conducted tests for the General Electric Co. to find the reason for failures of large turbine disks and discovered that the stationary wave due to vibration in harmony with the speed of revolution was the most important single cause. The present paper embodies the results of tests made on bucket vibration by Mr. Campbell before his death, supplemented by comment and conclusions by Walter C. Heckman who was associated in the experiment for 2 yr.

It was determined that bucket breakage may be due to tangential vibration of the natural period of the bucket is an exact multiple, 2, 3 or 4 times the speed of revolution. Small buckets will have higher periods of vibration, so are not likely to give trouble and long, slender buckets can be safely used, if they are not thrown into resonant vibration at operating speed. Avoidance of this resonant condition can be achieved by proper design and tuning, the tuning being done by vibrating the bucket before putting it on the wheel.

Vibration period depends on stiffness and mass so can be changed by altering these qualities. Making the connection to shroud rings more rigid is one means. Decreasing mass by removing metal at a point where it will least affect stiffness is another; i.e., at the outer ends.

It is found that buckets below 10 in. in length give little trouble. Above that buckets are designed and tuned so that the natural vibration period will be at least 15 per cent away from the twice per revolution at running speed, 10 per cent away from three times per revolution and 5 per cent from four times per revolution. Troubles from 5, 6 and 7 times per revolution may be ignored. Formulas and methods are given for estimating the frequency of vibration of buckets by comparison with test data on similar designs of buckets which have been tested.

Turbine breakage has been a puzzling problem; while rare, it always causes great trouble and confusion, hence is a subject for major consideration.

The afternoon Thurston lecture on Engineering and Science in the Metal Industry by Dr. Zay Jeffries was of more especial interest to engineers in metallurgical practice and the evening was devoted to a session on National Defense.

Friday was taken up with Council and committee meetings and excursions and with visits to the Power Show, closing a week of such value and interest as has seldom been equaled in the history of society meetings.

General Electric Co. Revises General Purpose Motors

WITH THE MARKETING of a new type of direct current motor and a redesigned type of alternating current motor, the General Electric Co. is now manufacturing a completely revised line of "general purpose"

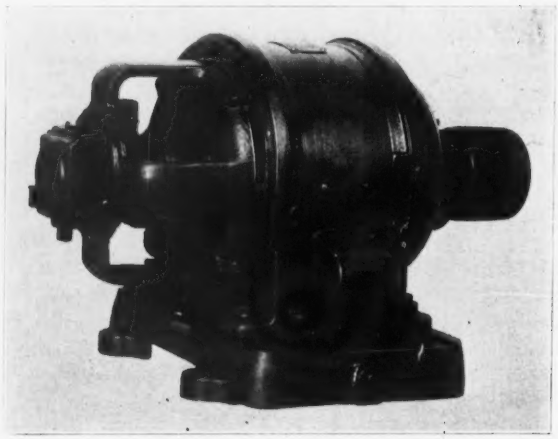


FIG. 1. TYPE BD-45, 2-POLE, 3-HP., 1750-R.P.M., 230-V, SHUNT WOUND MOTOR

motors. This line includes all standard speeds and horsepower ratings for use on any standard circuit.

Distinct advantages are claimed as a result of this revision. The use of the steel shell, babbited bearing, first adopted on KT-300 motors, has been extended to cover all general purpose motors. While strongly advocating

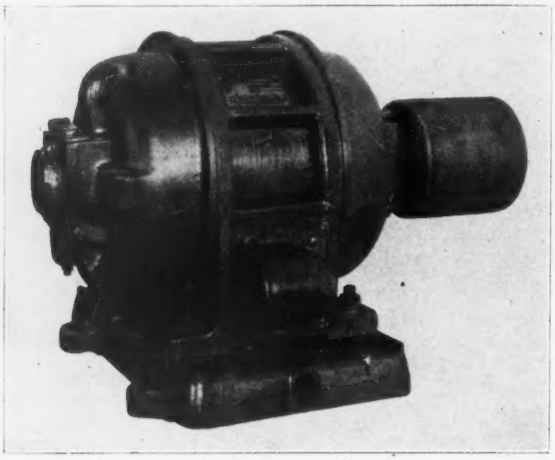


FIG. 2. TYPE KT-502 INDUCTION MOTOR

the use of sleeve bearings on its motors, the General Electric Co. has also made provision to furnish many of its standard types of general purpose motors with ball bearings for use by those who prefer this type. A further advantage resulting from the revision is the fact that some of the smaller direct and alternating current motors, rating for rating, are mechanically interchangeable.

Redesigned alternating current motors supersede the KT-300 line and are designated as KT-500. These motors are for use on polyphase circuits and are made in two types of rotor construction, the squirrel cage and the wound rotor design. Standard power ratings range from 5 to 200 hp. The squirrel cage rotor motors bear the designation KT-500, and the wound rotor type, MT-500. All are of the skeleton frame type and include both horizontal and vertical machines. The horizontal motors are suitable for belt, gear or chain drive or for direct connection, and the vertical machines are mainly adapted for direct connection.

Improved bearing construction is the keynote of the redesign of the alternating current types. Details include larger shafts and bearings, larger oil rings with lower oil level and larger oil reservoir capacity. The oil ring is retained in its slot by a guard permanently attached under the bearing screw. Other improvements include the use of spring oil well covers and improved insulation in the small, closed slot frames. The improved insulation, now included as standard on smaller sizes, makes these motors suitable for operation in places where special atmospheric conditions are encountered. The redesign of bearing housings is expected to eliminate minor troubles from oil leakage and to reduce the maintenance cost and amount of attention required.

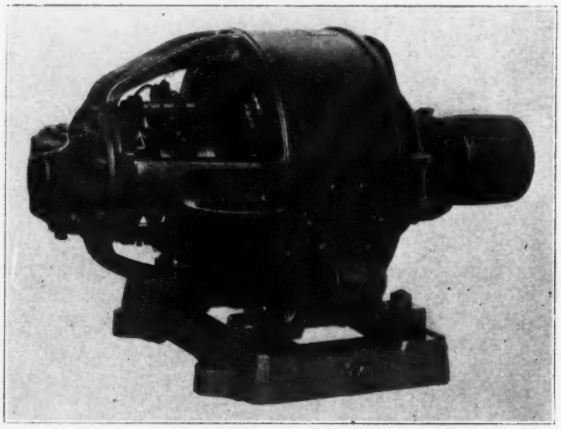


FIG. 3. CD-65, 4-POLE, 230-V. SHUNT WOUND MOTOR

New direct current motors include both constant and adjustable speed machines. The bi-polar type bears the designation BD and the four-pole motors are designated as Type CD. In view of the very flexible electrical and mechanical design, the older Types RC, RA, LC, RT, C, and, in some cases, RF motors, are now superseded by the new lines. Thus the same line runs from slow speed blower motors to high speed motors for driving pumps, including all intermediate types.

The BD and CD types range from ½ to 200 hp., the former being two-pole machines made in sizes from ½ to 3 hp., 1750 r.p.m., and the latter, four- and six-pole, running from 3 to 200 hp. Speeds used are 1750, 1150 and 850 r.p.m., these corresponding with full load speeds for General Electric 60-cycle induction motors. Thus, the motors are interchangeable as far as speed is concerned and this feature also applies mechanically, to some extent, to the frames used in the BD line. These direct current motors are made for use on standard circuits of 115, 230 or 550 v.

Improvements found in the new direct current line are mostly mechanical. The standard General Electric steel shell, babbited bearing linings are used except in

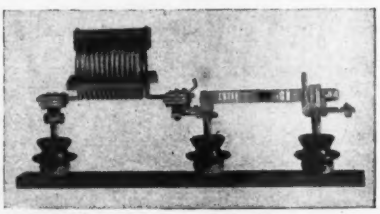
cases where ball bearings are preferred. The popularity of the riveted frame construction for small ratings of alternating current motors led to the adoption of this type of frame in the new BD motors.

As a result of these changes, the standard lines of general purpose motors are much simplified. Alternating current motors include the KT, MT and SCR types, the SCR, KT-900 and MT-900 machines having been introduced during 1923. All KT motors utilize the squirrel cage rotor and are constant speed machines for use on polyphase circuits. The MT machines are also for use on polyphase circuits, are constant or adjustable-varying speed, and utilize the wound rotor. Single-phase motors are covered by the SCR type, these being constant speed machines ranging from ½ to 10 hp. The new BD and CD motors comprise complete direct current line.

Another advantage of the standardization of these general purpose motors is the simplification of the renewal parts problem with specific reference to bearing linings manufactured for alternating current types, both single and multi-phase, thus enabling motor dealers to supply bearings for either alternating or direct current motors from the same stock. Most of the bearing linings, also, are interchangeable in any given type of motor, a total of approximately 2500 ratings listed, utilizing not more than 23 different bearings. As a result, large users of motors are enabled to simplify the ordering and stocking of new bearings. This simplification promotes prompter service to users and enables both dealer and user to stock extra bearing linings in less space and more economically than heretofore.

New Combination Disconnecting Switch, Fuse and Choke

ONE OF THE new products recently brought out by the Westinghouse Electric and Manufacturing Co. is a combination disconnecting switch, fuse, and choke coil, de-



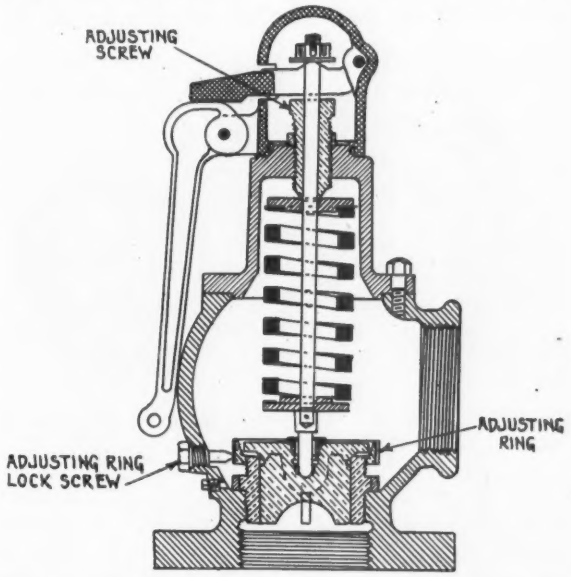
COMBINATION DISCONNECTING SWITCH, FUSE AND CHOKE COIL

signed to reduce the size and weight of the combined unit as well as the number of insulators required for a given installation. The possibility of trouble through insulator failures is reduced, and a saving in initial and upkeep costs is effected.

Insulator assemblies, such as are standard for other lines of Westinghouse outdoor apparatus, are used with these combinations. These standardized insulator assemblies employ only three bolt circles for the complete line. Two combinations are available, one with underhung and the other with inclined insulators, both of which use the same assemblies for a given voltage rating. The insulators have sanded heads and pin holes which adhere firmly to the cement. All hardware is galvanized and is provided with cupped and ribbed holding surfaces from which the cement cannot slip. The Portland cement, used at both cap and pin, is steam set so that injurious stresses due to temperature changes will be avoided. The combinations are available for all voltages up to and including 110,000 v.

Lonergan's New Safety Valve

WHEN THE American Society of Mechanical Engineers revised its boiler code for 1925, certain changes were made necessary in the design of safety valves to make them conform to the revised code. In answer to this requirement, J. E. Lonergan Co. of Philadelphia has brought out its model WRT pop safety valve



NEW LONERGAN SAFETY VALVE DESIGNED FOR HIGH LIFT OF DISC

for return tubular boilers. The discharge capacities of these valves are based on the boiler nozzle capacities given in the code and reports of tests show that these sustained capacities are exceeded by the new valves.

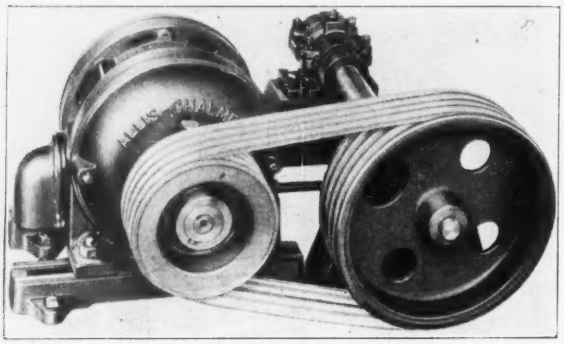
Safety, capacity and simplicity were the prevailing requirements in the design of these safety valves. By reference to the sectional drawing, it will be seen that by detaching the bonnet, the entire working parts of the valve may be removed for inspection or repair without disconnecting the steam piping. The springs used in these valves are of steel developed to resist high temperatures and the load which they carry is equalized by step washers, top and bottom, resting on ball joints. The spring is long and provided with sufficient clearance between turns to give the disc a high lift, positive opening and gradual closing with minimum desirable blow-down which may be adjusted from the outside. This is accomplished by removing the adjusting ring lock screw and screwing the adjusting ring up or down by means of any convenient metal point which engages in grooves in the surface of the ring.

Another feature of this valve is the cam lifting device which may be turned in any direction making it convenient for the operator and also the designer in planning the installation. These valves are made in sizes from 2½ to 4½ in. and for boiler pressures ranging from 15 to 250 lb. gage.

Flexible Drive for Short Centers Employs V Belts

FOR SHORT center machinery drives, a new device known as the Texrope drive, illustrated in the accompanying photograph, has recently been placed on the market. This is a flexible drive, consisting of two grooved sheaves and a number of specially constructed V belts, as shown. The sheaves are set just far enough apart so that the belts fit the grooves without tension or slack.

The Texrope drive is designed to prevent slip and lost motion, since the belts just fit the sheaves; it has also been found that, on account of the V construction of these belts, the harder the pull the more firmly they grip the grooves.



ENDLESS V BELTS FIT GROOVES IN SHEAVES OF TEXROPE DRIVE

In addition, the use of an elastic and stretchable material for the belts is designed to eliminate jerking in starting and running and to prevent the transmission of vibration from one machine to the other. Since no belt tension is employed, bearing pressures are low. The drive has been developed to occupy small space, to be silent, clean and unaffected by moisture and dirt, and to give fixed and exact speed ratios.

Texrope drives of from ½ to 250-hp. capacity, with speed ratios as high as 7 to 1 and belt speeds of 800 to 6000 ft. per min. have already been placed in service. They have been applied to the driving of textile machinery, machine tools, mining equipment, elevators and conveyors, paper and rubber mill machinery and the like. This drive has been developed by Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Heavy Duty Water Gage and Try-Cocks

IN THESE new devices, made by the Wright-Austin Co., Detroit, Mich., heavy construction and convenience of operation are the features which distinguish them. The water gage is of the usual design with chain pull for opening and closing both valves at once, but the construction is heavy in all parts and has gage glass washers of special construction to withstand high pressures. Large size of the valve-stem stuffing-box and gland are also notable.

Try-cocks are of weighted type, opened by chain pull and closed by the weight, which is held to the stem by a friction washer so that the weight can be adjusted to any angle. These weights are of such design that, no matter how closely centered the cocks may be, they can be opened wide without interference. Monel metal valve and seat are reversible and easily renewable without taking the try-cock off the boiler or water column, the monel metal being used for durability. Construction is heavy, being of brass

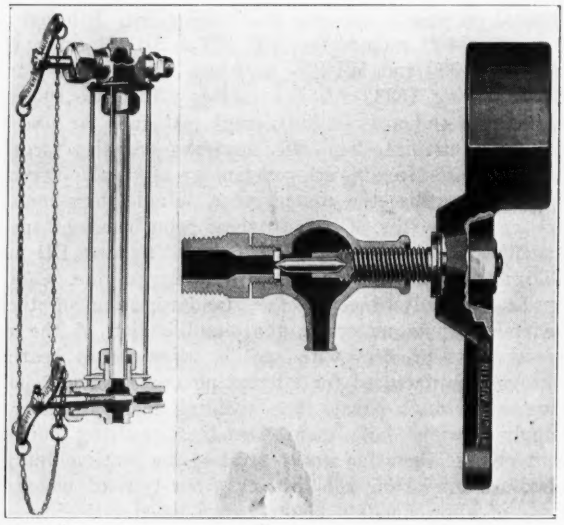


FIG. 1. HEAVY CONSTRUCTION IS THE CHARACTERISTIC OF THIS WATER GAGE

FIG. 2. MONEL METAL VALVE AND SEAT AND ADJUSTABLE, NON-INTERFERING WEIGHT ARE THE FEATURES OF THE NEW TRY-COCK

for pressures up to 250 lb. and of monel metal for higher pressures.

New Parts Are Designed for Jones Stoker

TWO IMPROVEMENTS have recently been announced in the construction of the Jones stoker. The first of these is a new type of plow shaped rear dead plate, shown

FIG. 1. NEW TYPE PLOW SHAPED REAR DEAD PLATE AND REDESIGNED TUYERE BLOCKS, AS INSTALLED IN STOKER

at the left of Fig. 1. With the type of rear dead plate formerly installed on this stoker, the fuel bed was permitted to move towards the rear of the furnace and against the bridge wall, often resulting in an accumulation of clinker at this point. The new type of rear dead plate, shaped like a plow as shown, is designed to plow through the fuel bed and change its course to the side of the furnace, thus preventing difficulties caused by clinker adhering to the bridge wall.

Another change in the Jones stoker has been in the development of a new style of plate tuyere block, shown in Fig. 2. This plate tuyere block is constructed to provide

cooling surfaces many times greater than the surface exposed to the heat of the furnace. It is stated also that the new type of block is so designed that it can be burned practically down to the retort, or as far as the shaded section shown below the line A B, Fig. 2, without increasing the area of the tuyere.

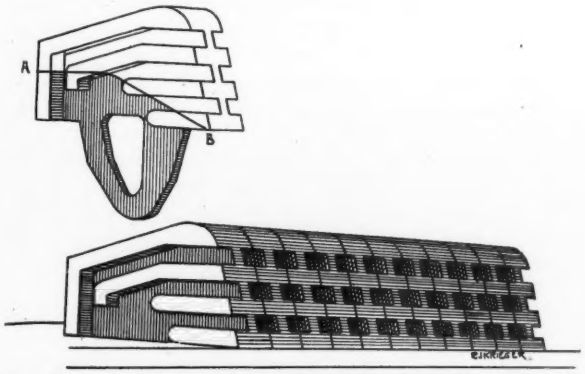


FIG. 2. TUYERE BLOCKS ARE DESIGNED TO BURN DOWN TO A B WITHOUT INCREASING TUYERE AREA

Figure 1 shows how the above parts are installed in the Jones stoker, which is manufactured by the Riley Stoker Corp., Worcester, Mass.

Multiple Indicator Shows Draft at Several Points

IN ORDER to operate the modern boiler house economically, it is necessary for the operators to have, among other things, reliable indications of the conditions of

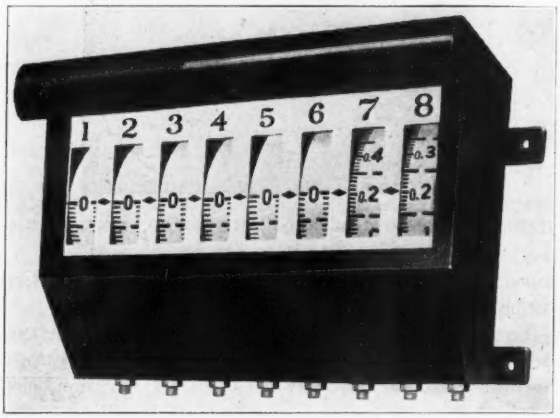


FIG. 1. FROM 3 TO 12 INDICATING UNITS MAY BE COMBINED IN CASE

draft and air pressure at various parts of their boiler settings. It is especially convenient also to have the instruments giving these various draft readings grouped together so that the relations between them will be readily apparent. To fill this need a new type of Republic multiple draft indicator has recently been placed on the market.

This instrument can be furnished to give any combination of indicating units from 3 to 12, for drafts or pressures not exceeding 8 in. of water. The indicators are enclosed in a case, as shown in Fig. 1, which may be bracketed to boiler front or panel. Illumination is furnished by electric lights in the reflector shown just above the face. Indications are read on the rotating discs, the edges of which are flush with the pointers on the face, so that they can be read at an angle.

Figure 2 shows the construction of a single unit of this indicator. Pressure or draft is transmitted through the ¼-in. inlet pipe at the right to the float or bell, which is sealed by being immersed in a tank of non-evaporating oil at the rear of the instrument case. The up or down motion of this bell is transmitted by the lever arms through the gear segment, which is fastened to the vertical arm, to the pinion on the disc, causing the latter to rotate. A pendulum weight, as shown, causes the balance to return to a definite zero position; magnetic damping is

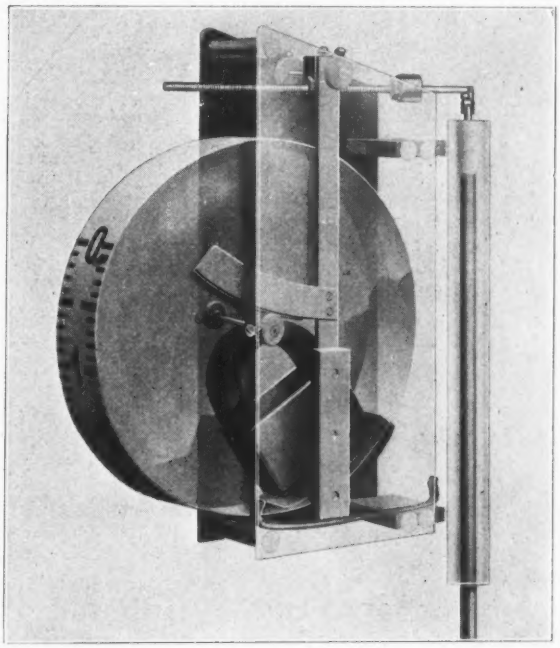


FIG. 2. SINGLE INDICATING UNIT, SHOWING HOW MOTION OF FLOAT IS TRANSMITTED TO DISC BY LEVERS AND GEAR SEGMENT

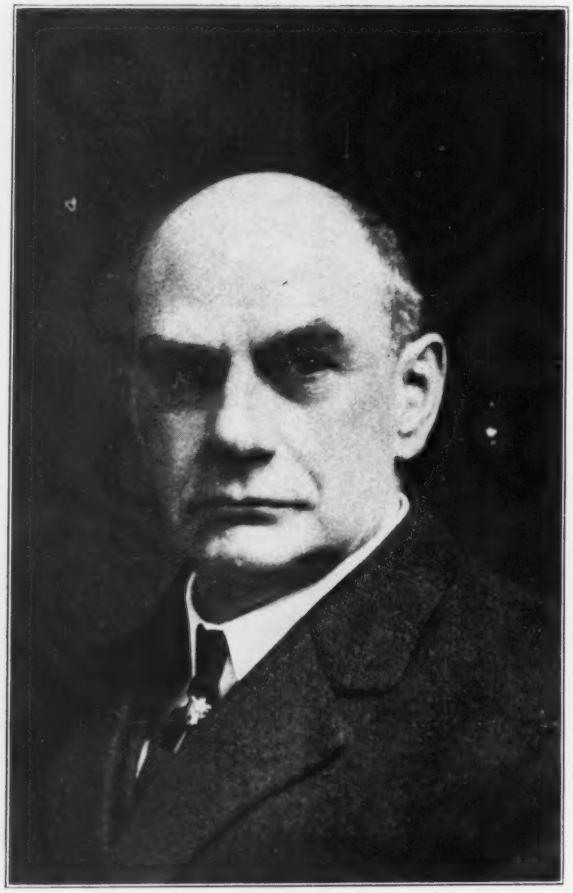
employed to cause the mechanism to act instantly even when there is a large change in the amount of draft. Provision is made for adjustment of the disc so that it will turn off the exact number of units corresponding to the change in draft or pressure, and the position of the counterweight or size of float may be changed so that the same mechanism may be used for different drafts and pressures.. Readings on the disc are spaced over 320 deg. so that wide divisions are secured. The Republic multiple draft indicator is made by Republic Flow Meters Co., Chicago, Ill.

THE GEOLOGICAL Survey, cooperating with the Virginia Geological Survey, has just published a new edition of the map showing electric power stations and transmission lines used in public service in Virginia and the river gaging stations maintained or proposed. The map has been prepared in connection with the work of collecting up-to-date statistics relating to the production of power at central stations and has been published in connection with a cooperative investigation of Virginia's water resources.

William L. Abbott

INSTALLED AS PRESIDENT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS AT ITS ANNUAL MEETING

MR. ABBOTT is too well known in the power plant field to need introduction. For many years he has been chief operating engineer of the Commonwealth Edison Co. of Chicago, as well as holding important positions in engineering societies, as Trustee and President of the



Board of the University of Illinois, and taking an active part in research and presentation of his findings to his fellow engineers.

Coming from a farm near Morrison, Ill., he entered the State University in 1880 and upon graduation came to Chicago which has since been his home. When 23 yr. old he, with F. A. Wunder, organized an arc-lighting company for the business district, which later became part of the Commonwealth-Edison Co. He also organized and was made president and general manager of the National Electric Construction Co., later purchased by the Chicago Edison Co. and Mr. Abbott was asked to come, too.

When the Harrison St. Station, at that time a model of efficient station engineering, went into commission, Mr. Abbott was made chief engineer and maintained good records of station performance there so long as it was the premier plant of the world. Then he stepped up to chief operating engineer of the company and, in that capacity has been responsible for performance of Fiske St., Quarry St., Northwest Calumet and last, the Crawford Ave. Stations, in addition to substations, transmission system and upkeep.

His help to young men has not been limited to his 16-yr. service on the Board of Trustees of the University of Illinois, for 12 yr. of which he was President of the Board, but includes much assistance to individuals, at the University, in the Commonwealth-Edison Co. and to returned soldiers and sailors.

In society work he has served as President of the Western Society of Engineers, on the Council of the A.S.M.E., and in many important committees of the N.E.L.A. and the A.I.E.E.

In electing him to the Presidency, the American Society of Mechanical Engineers has honored not only a man particularly worthy of it but one who is eminently fitted to give valuable direction to the conduct of the Societies' activities.

Link-Belt Achievement

FIFTY years ago was incorporated the Ewart Mfg. Co., forerunner of the present Link-Belt Co. and, in commemoration of its 50th anniversary, the Link-Belt Co. has

CHARLES PIEZ, CHAIRMAN OF THE BOARD, LINK-BELT CO.

embodied the story of 50 yr. of achievement in an attractive book titled Link-Belt 1875-1925.

Great industrial developments often start from small and apparently unrelated beginnings. In this case, so the book tells us, the start of chain transmission, chain and bucket conveyors and coal and ash handling systems of our modern plants was an idea for a square detachable link chain conceived and patented in 1874, by William Dana Ewart, a young implement dealer in Iowa, who was seeking an improvement on the chain drive used on self binding harvesters so that repairs could be made in the field.

Those to whom he showed his invention realized its possibilities for other uses and new uses developed rapidly so that new companies were formed for manufacturing parts and chains for conveying machinery, for coal storage systems, for cranes, for coal washing plants; all these were later brought together, under the leadership of Charles Piez, into the Link-Belt Co. Men who have been associated with this growth bore names familiar to power-

plant engineers. Louis Wright, James M. Dodge, Edward A. Turner, Staunton B. Peck, Alfred Kaufmann, Charles Piez are all names identified with the development and improvement of power plant operation. Ten large manufacturing plants, seven warehouses and twenty-seven branch offices now make up the visible accomplishment of their effort. And in nearly every industrial plant will be found machinery whose drive dates back in principle to the Ewart chain.

The present organization has as its head Charles Piez, Chairman of the Board, who it will be remembered was Director General of the Emergency Fleet Corp. during the world war; Alfred Kaufmann is president, Staunton B. Peck, Arthur C. Johnston and Humphrey, vice-presidents, and Richard W. Yerkes, treasurer and secretary.

News Notes

FOR THE SPRING meeting of the American Society of Mechanical Engineers, to be held in San Francisco in 1926, arrangements are being made to give members a special all-Pullman trip, leaving New York June 14 and arriving in San Francisco the 27th, going by way of Chicago, Kansas City, Denver, San Diego and Yosemite National Park. The party will stay in San Francisco during the spring meeting of the Society and will return by way of Puget Sound, the Canadian Rockies, Winnipeg, Minneapolis, St. Paul, Detroit and Niagara Falls, arriving in New York about July 13. Numerous side trips and receptions will be arranged in connection with this 3500-mile trip.

Meetings of local sections of the A.S.M.E. are in prospect as follows:

Chicago—Dec. 15, at the rooms of the Western Society of Engineers. Don B. McCloud will speak on "The Production of Oxygen by Liquefaction."

Denver — Dec. 18, at the Metropole Hotel. F. W. Whiteside will speak on "Coal Mining Methods in the Rocky Mountain Region."

Houston—Dec. 15, at the University Club. I. F. Hockaday will speak on "Industrial Electricity,' illustrated with motion pictures.

Tulsa, Okla.—Dec. 18, at the Mayo Hotel. J. O. Lewis will speak on "Cleaning Oil Wells with Compressed Air."

New Haven—Dec. 17, at the Mason Laboratory. Ladies' night will be held.

Philadelphia—Dec. 29, at the Engineers' Club of Philadelphia. The meeting will take up the Production and Use of Gas for Industrial and Domestic Purposes.

THE 1926 MEETING of the National Electric Light Association will be held in Atlantic City, May 17 to 21, and arrangements are being made for an exhibit of apparatus on the million dollar pier where the meetings will also be held. Every effort is being made by the committee to secure early applications for space and to make early assignments, as in past years late applicants have been unable to secure the space they desired.

Information may be had from George F. Oxley, Director of Public Information, N.E.L.A., 29 W. 39th St., New York.

THE SOUTHERN OHIO ELECTRIC CO. has concluded negotiations for the purchase of the Hocking Power Co., Nelsonville, Ohio; Southern Ohio Power Co., Floodwood; and the Mutual Electric Co., Middleport, Ohio, and will take over and consolidate the properties at an early date. Plans are under way for extensions and betterments, including transmission line and substation construction. The acquired properties are valued at $3,000,000, and will be financed in part by a bond issue recently arranged by the purchasing company, in amount of $2,000,000. The Southern Ohio Electric Co. was formed recently to take over and merge a number of utility properties in the southern portion of the state. M. M. Morrow is president.

BRIDGEPORT BRASS CO. announces the appointment of H. A. Watkins as metropolitan district sales manager with offices in the Pershing Square Bldg., New York City.

THE G. M. BASFORD CO., at a recent meeting of its board of directors, elected Roger S. Wensley, president and director, to fill the vacancy caused by the death of G. M. Basford. Walter F. Mulhall has been elected vice-president. Other officers and directors of the company have not been changed.

ALLIS-CHALMERS MFG. CO. is opening a branch sales office at Houston, Texas, in charge of R. I. Moore, who was previously located in its Dallas office. Temporary quarters are in the Rodgers Building and after the first of the year the office will be located permanently in the Post Dispatch Building. The Houston office will be operated as a branch of the Dallas district, of which E. W. Burbank is District Manager.

CONSTRUCTION WORK on a new building to house the electric distribution department has been begun by the Los Angeles Gas and Electric Corporation. The structure is to be three stories in height and is to have a total floor space of 60,000 sq. ft. It is to be located between Pico and Fourteenth and Wall and Myrtle Streets. All electrical testing laboratories are to be quartered here and all offices of the entire electric distribution department. Approximate cost has been set at $400,000 and it is planned to have the building completed early in February, 1926.

LANCASTER IRON WORKS, INC., of Lancaster, Pa., has recently purchased considerable industrial property on the Harrisburg Pike and the Pennsylvania Railroad, together with buildings, machinery, tools and equipment of the Monitor Bi-Loop Radiator Co. It is planned to complete the new steel boiler shop, recently erected by the Monitor Co., which will give at least 50 per cent increase in shop capacity. The Monitor Bi-Loop Radiator Co. will occupy warehouse space on the site and concentrate its efforts on sales while the Lancaster Iron works will have charge of production of these radiators as well as its former products of clay-working and brick-working machinery, tanks and steel plate construction.

THE PHILADELPHIA ELECTRIC CO., Philadelphia, Pa., has started operation in the first unit of its new Richmond power plant, in course of construction for a number of months past. The plant is located on the Delaware River in the northern section of the city, between Lewis Street and Erie Avenue. The initial unit has a capacity of 50,000 kw., and is one of 12 such units to be installed. Work on the other portions of the plant will be placed in active progress. It will consist of three separate buildings, each structure to house four generating units, with capacity of 50,000 kw. each, or a gross rating of 600,000 kw., designed as the largest steam-operated generating plant in the world. The plant will have a frontage of 3000 ft. on the Delaware River, which will be arranged with two coal piers, each 70 ft. wide and 400 ft. long, equipped to handle about 12,000 t. per day from barges

to the power station bunkers. It is said that the average fuel consumption at the complete plant will total 5000 t. per day. James Hunt, heretofore superintendent at the Schuylkill station of the company, Twenty-eighth and Christian Streets, will be superintendent at the new plant. Joseph B. McCall is chairman of the board of directors, and Walter H. Johnson, president.

Catalog Notes

FOLDER ISSUED by The Goulds Mfg. Co., Seneca Falls, N. Y., shows the use of its pumps on pipe lines for handling petroleum products and water supply in refineries.

CRANE PACKING Co., Chicago, Ill., is distributing its fifth edition of "Metallic Packing" which is a book of 124 pages devoted to the use of packing for all purposes about the power plant.

PHILLIPS COAL spout swinger is described in Bulletin SS-1, issued by Henry Pratt Co., 2222 So. Halsted St., Chicago, Ill. This device is designed to distribute the coal evenly in stoker hoppers in such a way as to maintain a uniform condition of the coal in all parts of the hopper.

STETS Co., 141 Milk St., Boston, Mass., has recently issued a pamphlet describing the Stets boiler feed controller, which is a float operated device. The bulletin describes types A, B and C and gives a detailed description of the Stets controller valve.

PENNSYLVANIA PUMP & COMPRESSOR Co., Easton, Pa., has just issued a new general products catalog No. 125, which describes in a clear, concise form the company's complete line of products including air compressors, vacuum pumps, after coolers and centrifugal pumps.

THE GRISCOM-RUSSELL Co., New York City, has just issued a folder which describes briefly condensers, heat exchanger, gas and water coolers, evaporators, oil heaters, separators and regulating devices, particularly adapted to oil refinery service and includes references to bulletins in which these units are more fully discussed.

GENERAL ELECTRIC COMPANY'S Bulletin GEA-10, superseding 46501-E, is devoted to the description of G-E mechanically operated flow meters for measuring fluids and gases. The bulletin goes into the details of construction, installation and general uses of these meters for use with steam, water and air.

ELEVATING AND CONVEYING MACHINERY is described in Bulletin No. 21, just issued by the Brady Conveyors Corp., 20 W. Jackson Blvd., Chicago, Ill. The bulletin discusses the bucket elevators, belt conveyors, coal and ash storage hoppers, bin gates and spur gear reducers made by the company and shows typical installations of this equipment that have been made.

THE HAGAN CORPORATION announces the publication of a new bulletin entitled "Water for Steam Generation" which is the outcome of a 4-yr. co-operative research between the Hagan Corporation and the United States Bureau of Mines, and deals briefly with the mechanism of Scale Formation and its Prevention. Copies will be mailed upon receipt of requests to the Hagan Corporation, Bowman Building, Pittsburgh, Pa.

AN AUTOMATIC change-over switch, designed to give continuity of service, and thus eliminate the serious losses occurring from the failure of voltage in such places as banks, hospitals, stores and laboratories, is described in a leaflet recently released by the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pa. This publication, L-20234, outlines the construction, application and distinctive features of this switch which is essentially three-pole, double throw, full automatic oil circuit-breaker with a low voltage release.

THE BROWN INSTRUMENT Co., Philadelphia, Pa., in its catalog No. 87, tells how Brown automatic temperature control instruments produce manufactured products of highest quality at lowest cost and describes a number of installations in industrial plants.

ALLEN & BILLMYRE Co., Inc., of New York City, is issuing a folder describing the Tabco Blowers and Exhausters of multi-stage centrifugal type. It shows the construction of the impellers and various types and applications of the apparatus.

MARION HEAVY DUTY STOKERS TYPE K is the subject of the bulletin recently issued by the Marion Machine Foundry & Supply Co., Marion, Ind. These stokers may be provided with full mechanical operating mechanism, semi-mechanical or hand levers. The bulletin illustrates the construction and describes the action completely.

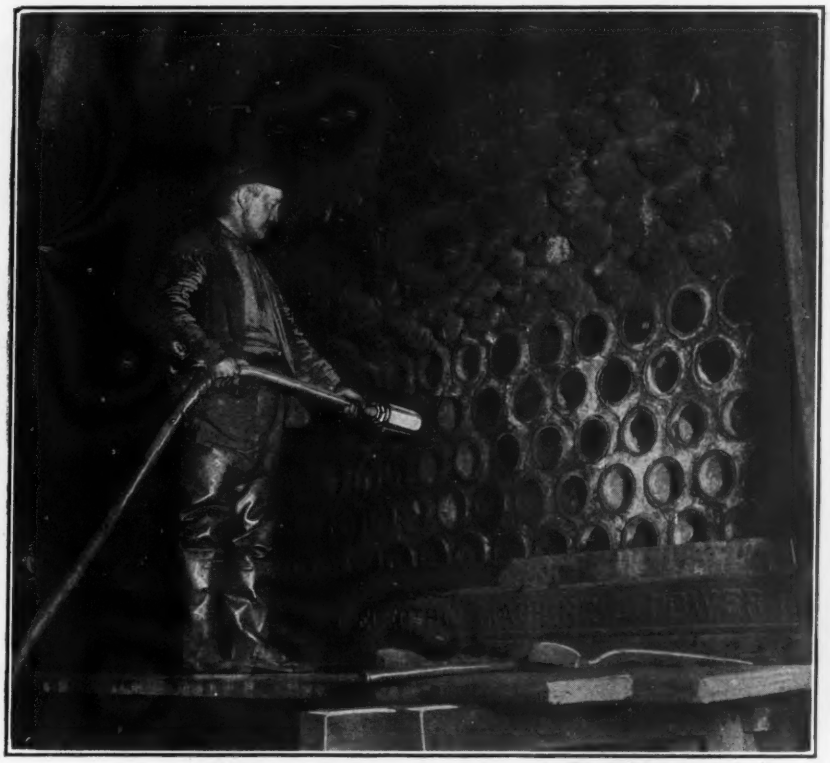
ALLIS-CHALMERS Bulletin 1132, which has recently been issued, relates to roller bearing motors, which are becoming popular in the industrial field. The bulletin illustrates the various points of advantage of these motors and gives a number of sectional views which show clearly their construction.

LADD WATER-TUBE BOILERS are described in Catalog No. 23, recently issued by The George T. Ladd Co., First National Bank Bldg., Pittsburgh, Pa. This catalog not only describes the general characteristics of Ladd boilers but calls attention to various details of construction which give efficiency, strength and accessibility with low expense for operation and maintenance to these boilers.

THE FULTON FOUNDRY & MACHINE Co., of Cleveland, Ohio, has just issued a new catalog giving general dimensions of the Fulton feed water heaters. This catalog is in the form of a series of blueprints showing the plans and elevations of various heater installations made by the company, together with capacities, size or fittings, pipe connections and general data. The catalog will be found of service to engineers planning the installation of these heaters.

THE WATER SUPPLY system of Tulsa, Oklahoma, which has the capacity to bring more than 28,000,000 gal. daily from the Ozark Hills, 60 mi. to the Northeast, is described in a pamphlet distributed by the De Laval Steam Turbine Co., of Trenton, N. J., which built the steam-turbine-driven centrifugal pumping units by means of which the water received from the tunnel is raised in pressure for distribution through the city mains. The leaflet gives much interesting information regarding the long concrete supply tunnel, and its hydraulic characteristics.

FIVE MINUTES with the Coal Bill is the title of a little book just received from Flynn & Emrich Co. It starts out by saying, "It is more than profitable that your coal bill was approximately 25 per cent more than it should have been." Then it gives numerous instances where a saving of 10 to 50 per cent in coal costs has been effected in plants running from 200 up to 900 hp. The book tells how it was done and what the returns were on the investment. You can get a copy of the book by writing Flynn & Emrich Co., 307 No. Holliday St., Baltimore, Md.



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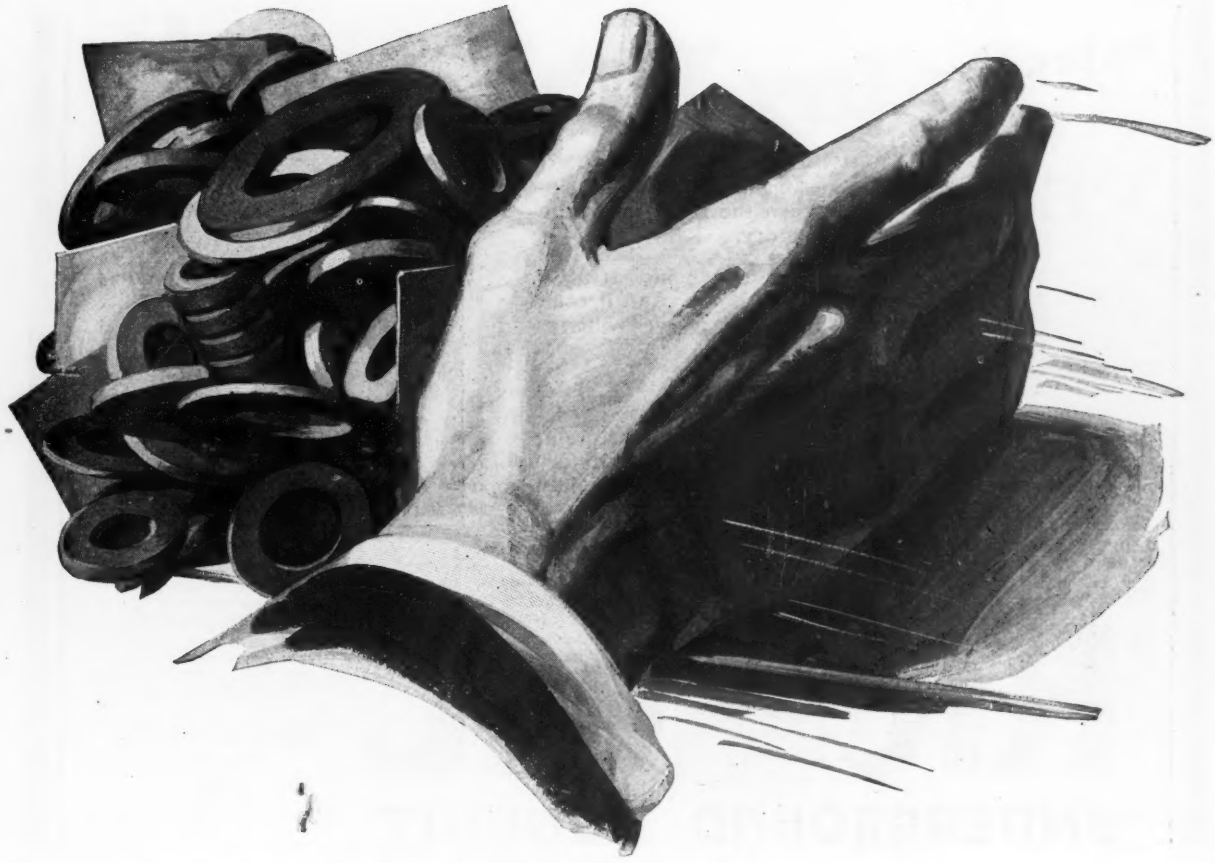

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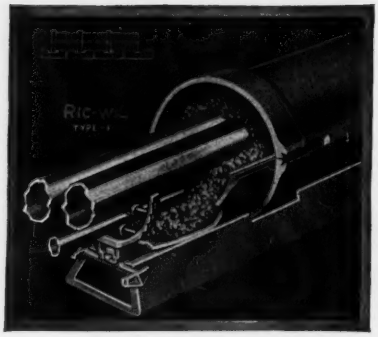

Note the compact interlocking construction — base drain supporting the conduit, pipe support carrying pipes free of the conduit, Loc-liP Side Joint sealing the split, and the insulating filler safe from moisture, always efficient.

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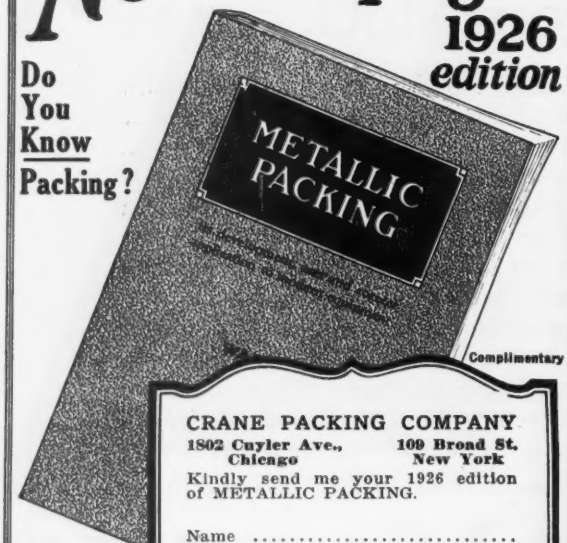

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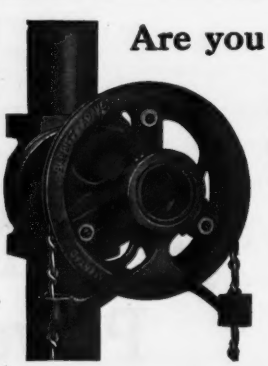

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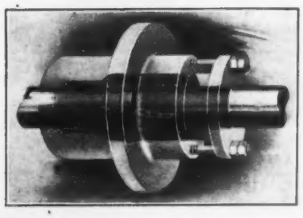
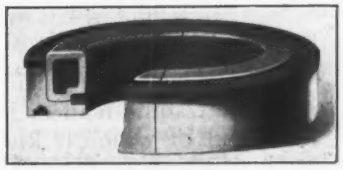
Saving money in every stuffing box in your own industry





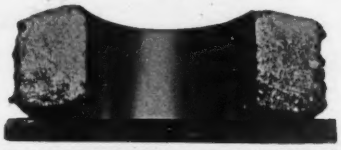
Consider the case of a certain engineer-owner who discovered, after two minutes' figuring that his $1.25 packing was costing him $135.00 per year in repacking, repair and replacement of shafts. Just a simple matter of arithmetic. Take any stuffingbox of any unit in your plant and see how many times you've had to repack; look at the stock you carry in your store room; make a rough estimate of the labor cost for each repacking, and the cost of the loss of pressure or vacuum or power or duty or gas or fluid or mix, during that shutdown period. Not alone what the packing costs per pound, but what it costs in money and trouble to keep your units running on that packing. Not only your major units but the auxiliaries as well,—the "little fellers" that chew up ordinary packing like a bulldog chews meat. There's where your money goes,—in a flock of little bills that slip through the office, and a flock of little jobs which keep your repair gangs steadily at work and your men on overtime. No reason for this expense, because new designs of Huhn Metal Packings have now been improved to an extent where there is a special type available for every condition in your plant—*an individually manufactured set of packing* that in the majority of cases will run as long as the equipment itself, without repair or replacement or leakage or loss. Shall we send you one of our big 24"x42" blueprint charts showing 24 of the metal packing designs which are guaranteed to cut your packing-operating bills in half? 30 cts. in stamps. Should be in every engine-room.

STEAM AIR WATER AMMONIA CO_2 OIL VALVES ROTARYS

HUHN MANUFACTURING CO.

Largest manufacturers of Metal Packing in the World

1393 Sedgwick Ave. New York, N. Y., U. S. A.



This Smooth, Frictionless Metal Bearing Is the Only Result of Years of Service

WHY not have Packings that *last like this?*

—you CAN—from a can of "CONNEAUT" PLASTIC METALLIC PACKING! Shapes like putty in the hand to fit any rod or stem in the plant. Lasts as only the very best bearing metal can last. Keeps tight for years. Practically frictionless. Write for free sample to The Conneaut Packing Co., Conneaut, Ohio. (If in Canada, address us at Hamilton, Ontario.) Sole makers of the packing that lasts—

"CONNEAUT" *Plastic Metallic*

Two Hands and a Can of "Conneaut" Make a Perfect Packing for Any Rod or Stem.

EUREKA PACKING

DON'T SIDETRACK

the important item of Packing A LIVE automatic expanding Packing—costs no more to install than a DEAD article—but the final results show in easier rod motion—more power—longer service—less rod wear and economy—all from absence of friction.

A glance at EUREKA'S construction—its other make-good qualities for ordinary pressures will be apparent to the thinking Engineer. We respectfully solicit an order through dealer or direct—Free delivery East of Denver.

EUREKA PACKING CO.

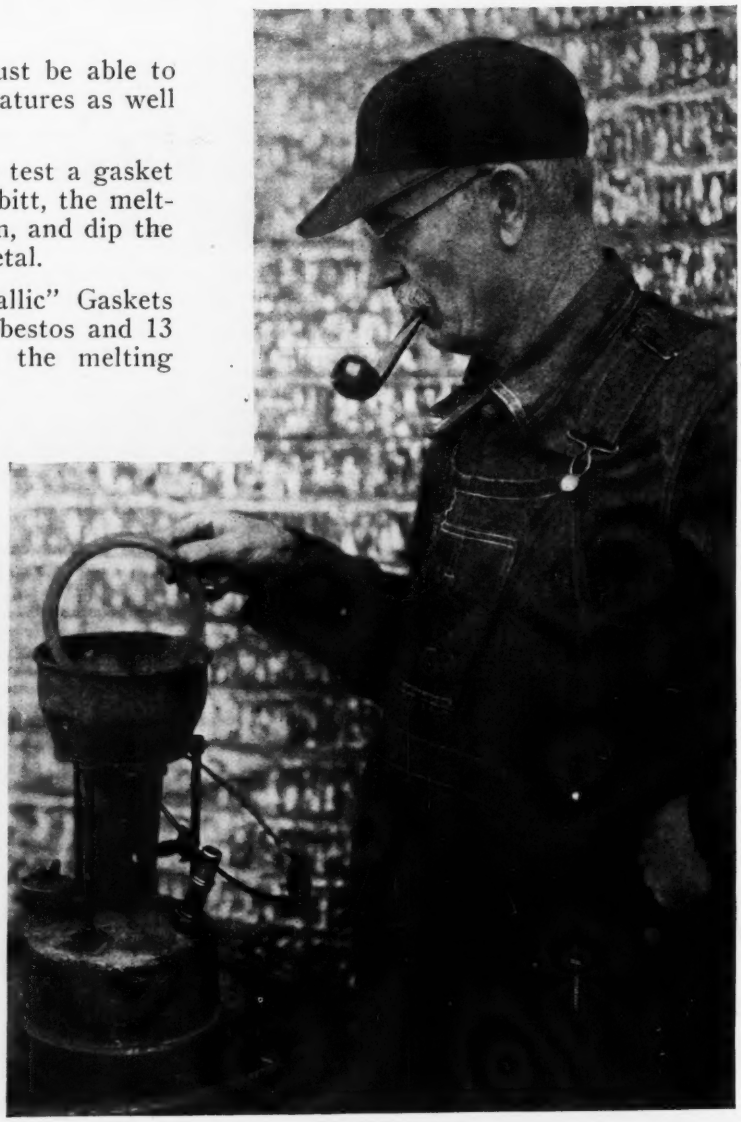
79-81 Murray Street, New York

Try this temperature test

AN up-to-date gasket must be able to withstand high temperatures as well as high pressures.

A good way in which to test a gasket is to melt some lead or babbitt, the melting point of which is known, and dip the gasket in the hot molten metal.

Of course, since "Flexitallic" Gaskets are made of 87 per cent asbestos and 13 per cent steel, and since the melting points of these two substances are considerably higher than the melting points of lead or babbitt, the "Flexitallic" Gasket will remain unaffected.



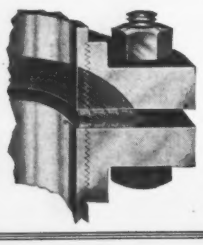
"Flexitallic"
Reg. U. S. Pat. Off.
Gaskets

This, remember, is only ONE "Flexitallic" advantage. We have covered some of the other advantages in previous advertisements. The "Flexitallic" is good, for example, because it is elastic. It is absolutely blow-out proof, durable, does not deteriorate in storage, and costs no more than other gaskets.

It is the ONLY gasket that is universally applicable to boiler tube caps, manholes and pipe flanges.

A very important advantage is its labor saving feature. It need not be screwed up tight. Joints can be made absolutely leakless in half the time.

Give us such details as: make of boiler if tube cap gaskets are wanted, inside diameter of bolt ring and inside diameter of pipe, for pipe flanges, etc., and we will send a reasonable number of free trial gaskets.



"Flexitallic" Gasket Co., Camden, N.J.
Reg. U. S. Pat. Off.

Do Your Gaskets and Packings Give Goetze Service?

SEND FOR the Goetze Guide on gaskets for pipe lines, valves, manholes, handholes; steam, water, air, gas and oil engines; compressors; chemical service; blast furnaces — any metal, size, surface. Also sheet, braided wire and metallic packings for stuffing boxes, valve stems, pumps, etc.

IT'S easy to find out. Just try Goetze Gaskets and Packings on your high operating pressures and temperatures—under severest strains of service. Then you'll insist always on Goetze Gaskets and Packings. You'll know then, too, how well the old, reliable Goetze Line compares with your present packings and gaskets.

One trial has been often the start to more savings in plant operation costs. Write the Goetze Gasket & Packing Co., 17 Allen Ave., New Brunswick, N. J.

Goetze *Flexible* Metallic Packing

—high grade, truly flexible packing completely encased by metal—in coils and rings for every service.

The password to better gasket service

REMEMBER "METALLO"!

This trademark on every box

MAKE joints leak-tight, prevent shutdowns, save labor and cut gasket troubles and renewals off your list, by making sure of METALLO SERVICE!

Only METALLO Gaskets can give METALLO service!

METALLO Copper-Asbestos Gaskets are made of 14-oz. deeply corrugated copper with heavy asbestos cord firmly laid in the corrugations—each cord and corrugation a leak-tight gasket in itself. They "give and take" between 1/8 and 1/16 inch—and stay tight.

Try a METALLO Gasket—90 days free.

METALLO Valve Discs

consist of a copper jacket completely enclosing a filler of heavy compressed asbestos packing. Resilient—they endure many reseatings. For Jenkins, Globe and other valves in any size. Outwear six ordinary valve discs.

Metallo Gasket Company

New Brunswick, N. J.

This Question of "Service"

SO MUCH has been said and written about "service" during the last few years that the average business man is getting suspicious of the word. He knows that business isn't knight errantry, and that no commercial concern is operating with purely altruistic motives. So, as soon as he hears the word "service," he begins to grow skeptical. However, there is a kind of "service" which, though intended primarily to protect the seller, is also a benefit to the buyer.

For instance, we know that

Standard Oils and Greases

are made right, from the highest quality crude oil especially chosen for its lubricating oil content, and that they will, if used correctly, give the most satisfactory results.

But—unless they are used correctly, the buyer cannot expect full satisfaction. No one grade of oil or grease will lubricate every machine properly. If the buyer uses the wrong grade for his equipment, he will be disappointed—and will probably blame it on the quality of our products.

Thus, we would lose a customer who might easily have become a constant purchaser if he had known how to select the right grade for his purpose. And the customer loses the satisfaction and the reduced operating costs that he might have secured by using the correct grades of lubricants.

Therefore, it is with a motive which is primarily selfish that we offer to our customers the services of our lubricating engineers. When our engineers have made a survey of a plant, and have recommended the grades of oils and greases that are exactly suited to its equipment, we know that the customer is going to be satisfied, and that we can count on him to become a steady purchaser.

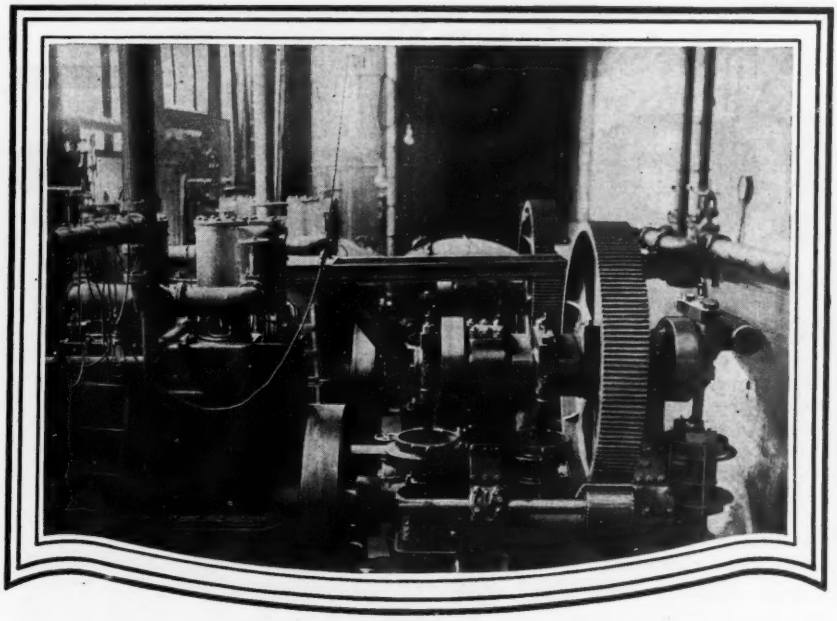
This service, which we have established for our own protection, is also a benefit to the customer, for it enables him to get full satisfaction from the products he buys, and to enjoy all the advantages and savings that result from perfect lubrication of his machinery.

We shall be glad to make a survey of YOUR plant
if you will phone or write us. The service is free

STANDARD OIL COMPANY

(Indiana)

General Offices: 930 S. Michigan Avenue Chicago, Illinois



For your gears and bearings

—use Tycol Greases . . . . they give the "film of protection"

A RUINED bearing, or a damaged gear can cause as much trouble and expense as a scored cylinder or a seized piston. Don't neglect the lubrication of these important parts of your machinery. They deserve the "film of protection" too!

Tycol Greases

The technologists of the Tide Water Engineering Bureau have been as careful to perfect lubricants for small bearings and rough gears as they have for large turbines and highly polished cylinders.

Tycol Greases, for use on bearings, high and low speed gearing, and industrial machinery in general, are of the same superior quality as the other Tide Water Power Group lubricants. In the manufacture of Tycol Greases, only the best lubricating oils and animal fats are used. There are no non-lubricating fillers added to increase the weight or consistency.

Why not have one of the Staff Engineers call to discuss the application of Tycol Greases to your machinery, and to give you additional information about the Tide Water Power Group?

The FILM of PROTECTION

—for Power Plant Machinery

IN their application to each phase of Power Plant lubrication, the lubricants comprising the Tide Water Power Group form the "film of protection", *thin as tissue, smooth as silk, tough as steel.* The application of the Tide Water Power Group to your machinery will give you truly economical lubrication—maximum power, uninterrupted operation and increased production.

The Tide Water Power Group

GRENOL

Pure Pennsylvania Cylinder Oils for all steam conditions, from wet steam to superheat.

DYNOL

Engine and Turbine Oils for engine bearings, turbines, generators and air compressors.

CLAROL

Machinery Oils for use in all classes of machinery, machine tools and line shafting.

TYCOL

Bearing Greases for bearings, high and low speed gearing and industrial machinery.

TIDE WATER LUBRICANTS

TIDE WATER OIL SALES CORPORATION

ELEVEN BROADWAY NEW YORK

OHIO Grease

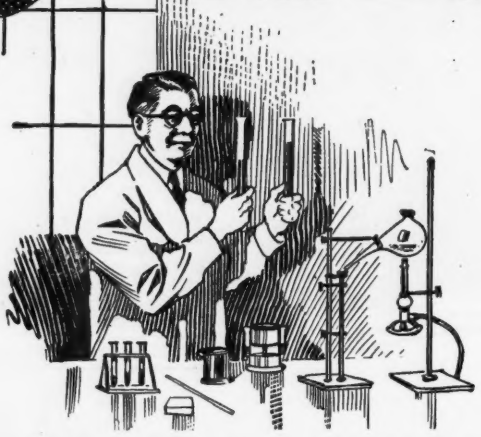
All Kinds of Exposed Gears

need Ohio Gear Grease for perfect lubrication under all conditions.

Thoroughly lubricates each gear tooth—prevents direct contact—reduces noise and friction, and increases power.

Water or weather will not affect it. Will not harden or dry up. A perfect lubricant for exposed gears under any conditions.

"Stock Carried in all Principal Cities"



The Ohio Grease Co. Loudonville, O.

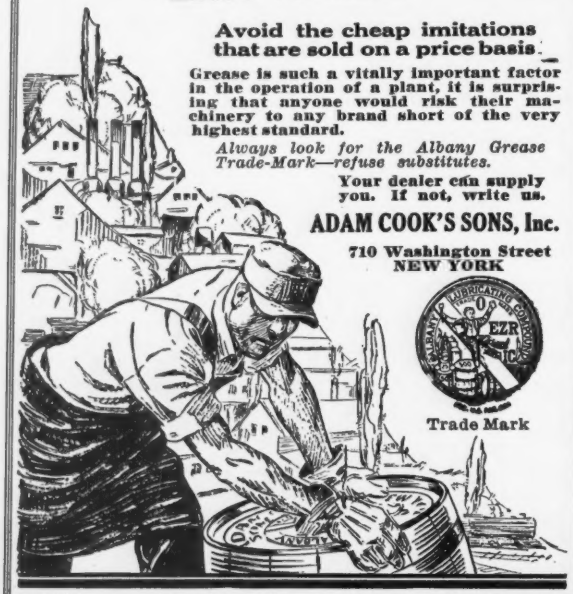
HI

Save your machinery from the junk heap

Protect Yourself—DEMAND

ALBANY GREASE

THE 100% **Lubricant** *NEVER DRIPS*



Avoid the cheap imitations that are sold on a price basis.

Grease is such a vitally important factor in the operation of a plant, it is surprising that anyone would risk their machinery to any brand short of the very highest standard.

Always look for the Albany Grease Trade-Mark—refuse substitutes.

Your dealer can supply you. If not, write us.

ADAM COOK'S SONS, Inc.

710 Washington Street NEW YORK

Trade Mark

The Keystone Lubricating Co.

Executive Office and Works: Philadelphia, Pa.

Dixon's Graphite Products

are made of the best and most suitable materials obtainable, compounded after a fashion determined by many years' experience.

Ticonderoga Flake Graphite
Graphite Cup Grease
Graphite Waterproof Grease
Graphite Joint Compound
Boiler Graphite
Graphite Brushes
Solid Belt Dressing
Silica-Graphite Paint

Write for Booklet 96-KP.

Joseph Dixon Crucible Company

Jersey City, New Jersey

Established 1827

You never need watch your step with—

IRVING PATENTED SUBWAY FLOORING

You cannot slip upon it, try as you will—even with water or snow, soap or grease or oil, upon it. Those edge-on steel bars never fail to grip the foot, even when highly polished with traffic. There's no "wear-out" to the non-slipping surface of **Irving Subway**—it is a permanently safe, comfortable floor for any industrial purpose.

Ask us for Catalog 4A-15

IRVING IRON WORKS CO.
LONG ISLAND CITY, N.Y. U.S.A.

P-62

Cling-Surface

The Belt Preservative—Lubricant

that assures full power from slack-running belts, eliminates tension and slip, reduces friction and lubrication costs.

Makes and keeps belts mellow, pliable, water-proof; preserved for longer and better service.

F. O. B. Warehouse Stocks in Different Centers

Cling-Surface Co.
1028 Niagara St., Buffalo, N. Y.

HARRIS OILS AND GREASES

A well-known industrial Oil engineer says:

"The importance of efficiently filtering and purifying turbine oils in use cannot be overestimated. The disintegrating effect of finely divided suspended solid impurities, such as fine rust, moulder's sand, and scale, sludge, etc., is quite evident. The oil becomes darker in color, and increases in acidity, while a dark slimy deposit develops generally first in the cooler, and oil takes on a peculiar "burnt" odor. Oil in this condition is quite susceptible to emulsification if moisture is introduced, which is inevitable in turbine operation."

If you would obtain the best possible results in the operation of your turbines, use Harris Special Turbine Oil.

THE A. W. HARRIS OIL CO.
329 So. Water Street, Providence, R. I.

"AMERICA'S LEADING LUBRICANTS"

THE GASKET SUPPLY CO. TRADE RIGHT MARK PHILADELPHIA, PA. U.S.A.

"RIGHT" Gaskets

Include All Kinds for All Purposes

The Mark of 21 Years' Special Service

Made of any material or combinations of materials, any shape and any size. We furnish the kind of gasket asked for, the gasket you find best adapted to your requirements, whether made of Copper, Brass, Cardboard, Cork, Lead, Leather, Iron, Steel, Monel Metal, Rubber, Asbestos, Paper, Felt, etc., or combinations of these.

Write for prices

The Gasket Supply Co., 1725 Ludlow St., Philadelphia, Pa.

Is this Wolf after Your Profits?

If your steam lines are insufficiently or inefficiently trapped, you are feeding the ravenous appetite of this black wolf—the black wolf of coal waste that is making a daily meal off of your profits. Just think! One untrapped ¾" steam pipe will waste more than a ton of coal every 52 hours. Away go profits—straight to the sewer, in form of live steam.

But you can positively prevent this waste. And at a cost of only $9.45 list, for a

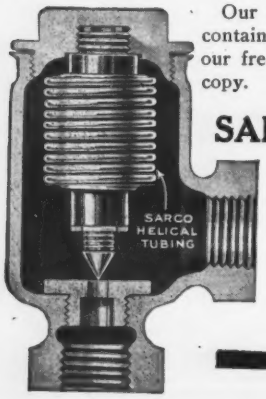
SARCO STEAM TRAP

In less than no time after you install a Sarco Trap, it has actually paid for itself in the coal it has saved.

The Sarco Steam Trap No. 9 is factory adjusted for any steam pressure from 0 to 100 lbs. It has merely to be screwed on the end of any steam line in an upright position. No leveling or careful installation required. No platform or pit needed.

Has no toggle joint to stick—just one moving part. Nothing to rust. Dirt will not choke it because the discharge is twice the size of the average opening in small traps.

The Sarco costs about one-third the price of most traps. Send for one on 30 days' free trial.



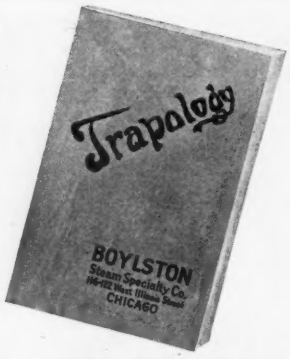
Our interesting booklet B-271 contains full particulars about our free trial offer. Write for a copy.

SARCO CO., Inc.

230 Broadway,
New York City

Boston, Buffalo, Chicago, Cleveland, Detroit, Philadelphia

Peacock Bros., Ltd., Montreal



Send for this book

It gives basic principles on selecting steam traps!

WHY manufacturers separate their traps into classes—Why an intermittent trap should be preferred to a continuous discharge trap—Why pay for complications when you can get simplicity—Strength of castings with no core—Advantages of a Get-at-able Trap—all these and many other topics are discussed in this 6x9 in. booklet which we send free on request. Write.

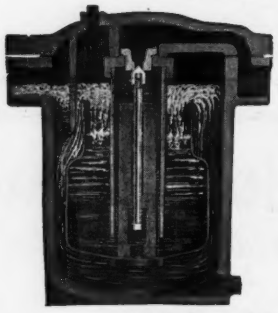
BOYLSTON STEAM SPECIALTY CO.
Main Office and Factory:
116 to 122 W. Illinois St., Chicago, Ill.
District Sales Offices in Principal Cities

BOYLSTON **Steam Trap**

ILLINOIS Eclipse

STEAM TRAPS

will end your trap troubles for all time



Instant, complete action—wire-drawing impossible—can't blow steam or airbind. Simple construction—only 2 moving parts—durable—greater capacity.

A 30-day trial will prove it

Send for bulletin 309

ILLINOIS ENGINEERING COMPANY
Robert L. Gifford, Pres. Incorporated 1900
Branches and Representatives in 40 Cities
CHICAGO

We've Built a Better "Bundy"

It wasn't easy. From the standpoint of "Bundy" users, it wasn't necessary. But "Bundy" has always built steam traps with a long look into the future—always anticipating demands upon all kinds of power plant equipment for higher and yet higher efficiency—so "Bundy Betterment" had to go on and "Bundy" leadership had to be still further increased. And so the New and Better "Bundy"—as you saw it at the Power Show—as it has been operating successfully for many months—is ready for the wide sale which these announcements will insure.

The Five New Features of the Better Bundy:

The Bowl, Pipes and Elbows are in one piece instead of five.

Trunnion troubles are positively eliminated.

Connecting Rod Links rock on knife edges instead of pivoting on pins.

New Valve Stem Attachment which does away with rigid connections, set screws and check nuts. No trouble in making adjustments or replacements.

Tilting action positively insured by ball-bearing lever.

All the old features that have made "Bundy" a synonym for steam trap satisfaction have been retained.

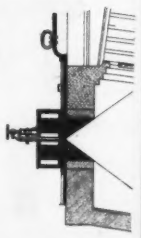
New catalog nearly ready.

Write for any further information you desire, and don't buy another steam trap till you've checked the New "Bundy" point by point against the best of the others.

BUNDY STEAM TRAP CO. 39 Elm St., Nashua, N. H.

SCHUTTE KOERTING FUEL OIL BURNERS

Complete systems including strainers, pumps, heaters and burners.



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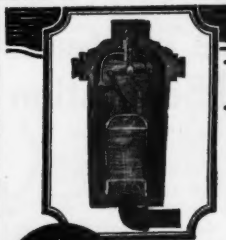
SCHUTTE & KOERTING CO.
1156 Thompson St., PHILADELPHIA, PA.



Better-in-5-ways

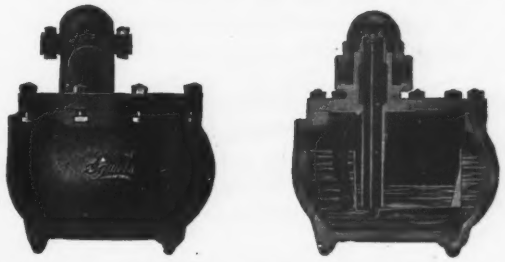
THE ARMSTRONG is better because its inverted submerged bucket principle brings 5 advantages; greater capacity—non-air-binding—self-scrubbing—no throttling—small size.

For pressures from 0 to 300 lbs. Get the free catalog. Write Armstrong Machine Works, 310 Maple Street, Three Rivers, Michigan.

Ask about free test offer

The Armstrong Steam Trap

Squires STEAM TRAP



The Genuine

Equipped to give simple, satisfactory and low-cost protection against steam waste in high pressure power plants and low pressure heating plants whenever a strong and durable steam trap is required.

Send for our Catalogue E-9

Squires

Trade Mark Reg. U. S. Patent Office

The C. E. Squires Company
E. 40th St. and Kelley Ave., Cleveland, Ohio

See Booth 35 Chicago Power Show

The Davis Pressure Regulator with counterweighted lever control. Pressure balanced by weight. Action visible and may be tested by hand. No diaphragm to give way—no packings to cause friction—no gasket to blow out—no springs to lose their power. Easily dismantled for cleaning. Sizes from ½ inch to 14 inches. Screwed, standard flanged, and extra heavy flanged ends. Also furnished with expanded outlet.

WOULD you pay fifteen cents for a five-cent cigar? Some men would. Would you use one hundred and fifty pounds steam pressure if fifty pounds were enough? Some engineers would. Others use Davis Pressure Regulators to reduce the boiler pressure to any lower pressure needed for auxiliary use.

G. M. Davis Regulator Co.
429 Milwaukee Ave.
Chicago, Ill.

1875—Valve makers for fifty years—1925

DAVIS VALVE SPECIALTIES

Water control valve
Balanced valve
Back pressure valve
Float valve
Pump governor
Exhaust relief valve
Stop and check valve
Non-return valve
Steam trap
Flow regulator
Emergency stop valve
Water relief valve
Pressure regulators
Fluid level controller
—and others. P.P.E. 12-15B-R.T.G.

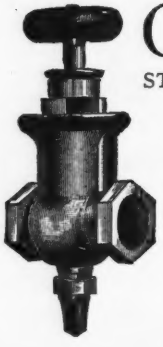
There's Money in Correct Control

of both boiler water level and operation of pumps which supply the feed water. We have shown notable savings in fuel, repairs and quality of steam by the use of the **constant level** control of the Cleveland Feed Water Regulator.

Supplementing this service is the smooth, even, dependable control of pump operation given by the B. Y. Pump Governor regardless of variations. Positively maintains any desired excess pressure.

Let us show you what they will save in your plant—the many leading plants that use them—their simplicity of design and durability—their records of savings and service. And remember we offer a **free** trial. Write for bulletin today to

The Cleveland Feed Water Regulator Co.
2734 Tennyson Road Cleveland, Ohio

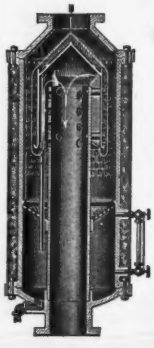


CURTIS
STEAM PRESSURE REGULATOR

Simple and Compact. Unrivaled for high efficiency.
Low maintenance cost.
Rugged design.
High grade material.

Send for descriptive circular and No. 56 catalogue.

Julian d'Este Company
26 Canal St., Boston 14, Mass.



***Service* in Steam and Oil Separation**

Sweet's Separators, the perfected product of 31 years' experience, have more than 10,000 successful installations to their credit. Naturally we have gathered much valuable data on solving separation problems, which is at your service.

The Direct Separator Co., Inc.
820 Geddes St., Syracuse, N. Y.

Insist on Sweet's

The moisture in your steam is Not distilled water—

IT IS WATER OF FULL BOILER CONCENTRATION

TRACYFIERS

Remove even the last ½ of 1% that otherwise would carry tons of solids into your steam lines and prime movers, to clog, erode and foul.

Send coupon for
P R O O F

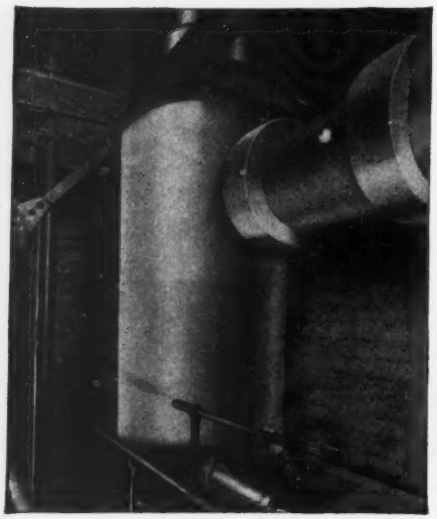
Andrews-Bradshaw Company
531 Fourth Avenue
Pittsburgh, Pa.

CLEAN STEAM TRACYFIER DRY STEAM
TRADE MARK

Send Coupon—Receive Complete Data

Andrews-Bradshaw Company, 531 Fourth Ave., Pittsburgh, Pa.
Send a copy of Bulletin No. 35
Name..... Company..... Address.....

TRACYFIERS CLEAN STEAM
Clean Steam Never Cuts



12-in. Angle Separator Under 275 lb. Pressure
200° F. Superheat—Side Inlet and Top Outlet

Specially Built Separators at Specially Low Prices

At some time in the past, Wright-Austin has solved the very same separator problem that confronts you now.

"Standard Special" separators enable you to profit by the wide variety of standard parts, the data, plans and patterns, which have been developed during Wright-Austin's thirty successful years in the manufacture of separators adapted to every pressure, temperature and steam velocity in commercial use.

You can incorporate your own ideas of piping arrangement and design; yet get a separator proven under conditions identical with your own at a price much lower than you would have to pay for an ordinary built-to-order separator.

Write for Details

Steam Traps **Steam Separators**
Air Traps **Exhaust Heads**

Oil Separators **Strainers**
Boiler Alarm Water Columns

WRIGHT AUSTIN

Standard since '94

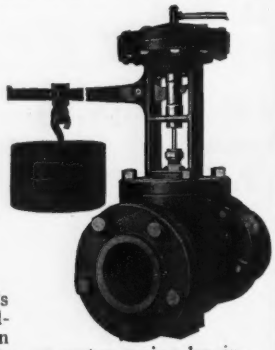
Wright-Austin Company

321 W. Woodbridge St., Detroit

(180)

Assure a Continuous Water Pressure by a

Fulton Tank Governor



WHATEVER head is desired may be steadily maintained in tanks, standpipes, reservoirs or water mains by installing a **Fulton Tank Governor.** This is a heavy, double-seated balanced valve, the stem engaging with a weighted lever. Automatic in operation. Pressure on the diaphragm closes the valve when the desired pressure is reached. When pressure decreases, the weighted lever opens the valve. No float valves or electrical devices.

Head to be carried may be increased or diminished by increasing or decreasing the weights.

Extremely delicate in operation. Meets the most exacting conditions.

The Chaplin-Fulton Mfg. Co.

28-36 Penn. Ave. Pittsburgh, Pa.

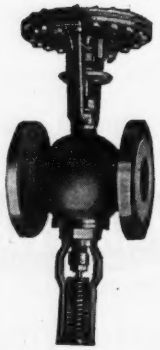
Manufacturers of the Vigilant Feed Water Regulator, Fulton Pump Governor, Reducing Valves and Other Steam Specialties.

Why "S-C" Regulators

are in

Central Stations of these Companies:

Union Gas & Electric Co.
Columbia Gas & Electric Co.
Commonwealth Edison Co.
Indiana General Service Co.
East Penn Electric Co.
United Electric Light & Power Co.
Dayton Light & Power Co.
Kansas City Light & Power Co.
Denver Gas & Electric Co.
Milwaukee Railway & Light Co.
American Gas & Electric Co.
Scranton Electric Co.
San Antonio Gas & Electric Co.
Detroit Gas Co.
Southern Power Co.
Public Service Co. of N. J.
Los Angeles Gas & Electric Co.
Philadelphia Suburban Gas & Electric Co.
Potomac Edison Co.



"S-C" Regulators maintain correct water level on all kinds of boilers from 75 hp. up. Catalogue No. 140 gives reasons why they are preferred and should be in your plant.

Regulating Valve may be placed anywhere in feed water line.

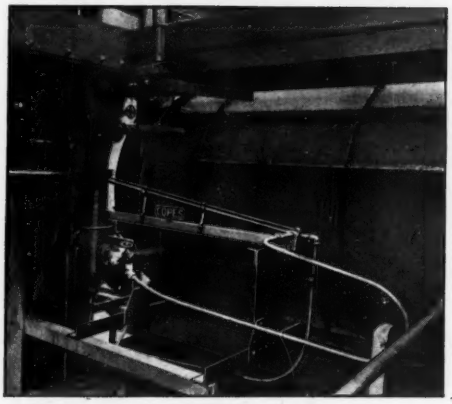
The "S-C" Regulator Mfg. Co.

Mechanical Regulation Engineers

Fostoria, Ohio

Manufacturers of "S-C" Feed Water Regulators, Pump Governors, Regulating and Relief Valves, Drainage Controls, etc.

11 out of 15



COPES Regulator installed on a 2768 Hp. B. & W. boiler fired with pulverized fuel at Colfax Station of the Duquesne Light Company.

The Facts

Union Electric Light & Power Co. (Cahokia Station)	COPES
Duquesne Light Company (Colfax Station)	COPES
Detroit Edison Company (Trenton Channel Station)	COPES
H. L. Doherty Company (Valmont Station)	COPES
Sioux City Gas & Elec. Co. (Big Sioux Station)	COPES
West Penn Power Company (Springdale Station)	COPES
United Electric Railways Co. (Manchester Station)	COPES
Illinois Electric Power Co. (East Peoria Station)	COPES
Penna. Water & Power Co. (Holtwood Station)	COPES
St. Paul Gas Light Company (Island Station)	COPES
Susquehanna Collieries Co. (Lykens Station)	COPES
Cleveland Electric Ill. Co. (Lakeshore Station)	
Milwaukee Elec. Ry. & Light Co. (Lakeside Station)	
Columbia Power Co. (Miami Fort Station)	
Narragansett Electric Lighting Co. (Providence Station)	

Of the last four stations, two feed by hand and two are equipped with regulators of other makes.

In this year's report of the Prime Movers Committee of the N.E.L.A., 11 of the 15 statements by operating companies in the Pulverized Fuel section cover installations that are equipped with COPES Feed Water Regulators.

Of the other four, two stations are feeding by hand and two are equipped with regulators of other makes.

Such outstanding preference among central stations that are setting new high records for efficient operation can mean but one thing: Feed Water input is controlled with greater safety, accuracy and economy by COPES Regulators than by any other means.

From these leaders on through to the small power plants, COPES Regulators are performing with most satisfactory results, for they are equally valuable on any size or type boiler.

NORTHERN EQUIPMENT CO.
175 Grove Drive, Erie, Pa.

Branch Plants: Hamilton, Ontario, Canada; London, England; Paris, France; Merseberg, Germany; Vienna, Austria; Milan, Italy.

COPES
SYSTEM OF BOILER FEED CONTROL

"No shutdown if a boiler tube bursts"

Golden-Anderson

"No shutdown if a steam pipe bursts"

Patented Automatic *Double - Cushioned* Triple Acting; and also Non-Return Valves

RELIABLE!

Give your plant the safe and high efficiency which puts these valves in every industry where satisfactory performance is demanded.

"4500" repeat orders have been received from the Steel and Iron Industry alone.

1. Prevent expensive shutdowns due to reversal of steam flow.
2. Instantly close and isolate a boiler when a tube ruptures.
3. Simultaneously shut off the steam flow from all boilers when a pipe bursts.
4. Automatically cut a boiler into the line.
5. Prevent back flow of steam into a cold boiler.
6. Positive fool-proof. No springs or adjustments to be made.
7. Can be tested in service.
8. "Double Corliss" dash pot that cushions in opening and closing.
9. Cannot spin, stick or chatter.

Golden-Anderson Valve Specialty Co.

1287 Fulton Bldg. Pittsburgh, Pa.

Golden-Anderson

Pat. Automatic Cushioned Water Float Valves

1. Automatically Maintain Uniform Water Levels in Tanks, Stand pipes, etc.
2. Instantly Adjusted to Operate Quickly or Slowly.
3. Floats Swivel to any Angle—Most Satisfactory Float Valves known.
4. No Metal-to-Metal Seats—No Water Hammer or Shock.
5. Cushioned by Water and Air.

Sizes ½ to 24 in.

Golden-Anderson

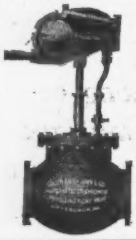
Patent Automatic Cushioned Controlling Float Valves

They carry a constant water level in feed water heaters by perfectly controlling the flow of makeup water.

Operated by protected enclosed copper float.

Cushioned by both air and water.

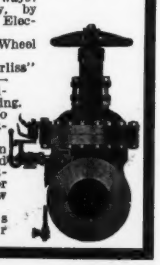
Operate without hammering, sticking or chattering. No metal-to-metal seats. Made angle or straightway.



Golden-Anderson

Pat. Cushioned Combined Throttle and Automatic Engine Stop Valves

1. Operate 3 ways: Automatically, by Hand or by Electric Switch.
2. Prevent Fly-Wheel Explosions.
3. "Double Corliss" Cushioned—No Pounding or Sticking.
4. Contain No Tight Fitting Parts.
5. Furnished in Angle and Globe Patterns for High or Low Pressures.
6. "Always Ready for Service."

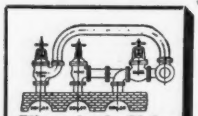


Golden-Anderson

Pat. Automatic Cushioned Steam Pressure Reducing Valves

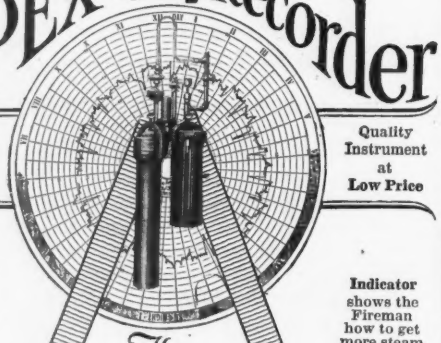
1. Maintain a constant reduced pressure.
2. Thoroughly cushioned.
3. No hammering, chattering or sticking.
4. No auxiliary valves or small by-passes to clog up.
5. No wire-drawing.
6. Only one adjustment from the outside.
7. Double extra heavy throughout—practically indestructible.

Double Extra Heavy Cast Steel Valves for Superheated Steam particularly adapted to Central Station Service.



Elbow Angle Globe

APEX CO_2 Recorder



Gas Sampling Line ALWAYS Clean

Quality Instrument at Low Price

Recording Gauge the Engineer's Guide to Combustion Efficiency

Indicator shows the Fireman how to get more steam with less work

The Trouble-Free Recorder

No moving parts.

No chemical solutions.

Write for chart showing "Fuel Savings Possible"

Exceptionally simple and durable.

UEHLING INSTRUMENT CO.

Combustion Engineers

470 Getty Ave., Paterson, N. J.

FISHER

TRADE MARK REGISTERED

Dependable Power Plant Specialties

The Fisher Governor Co.

677 Fisher Bldg., Marshalltown, Iowa

See classified directory for all Atlas Regulating Devices.

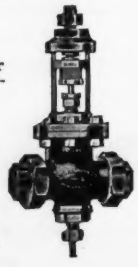
VIA victor ideal atlas

Can you remember this word?

It means "By way of."

It means that whatever your regulator problem, it can be taken care of

Victor
Ideal
Atlas



ATLAS VALVE COMPANY

REGULATING VALVES FOR EVERY SERVICE

291 South St., Newark, N. J.

RESPONSIBLE

For Accurate Pressure Control

Once a Mason Standard Reducing Valve is in the line, the responsibility for continuously accurate pressure regulation is off your shoulders.

You are assured of a dependability of performance that is the result of forty years of specialization in the manufacture of high grade pressure regulating devices. Superior design and high quality of materials and workmanship mean years of service at least expense for maintenance. It's true economy as well as sound engineering to specify Mason Regulators.

Your regular supply dealer can promptly furnish the types and sizes you require. For complete information write us for Catalog No. 62.

Mason Regulators are made in all types and sizes for reducing and controlling steam, air and water pressures and regulating pumps, engines, blowers, motors and furnace draft.

Mason engineers stand ready to consult with you on any problem of regulation.

Mason Regulators

MASON REGULATOR CO.
Boston, Mass.

8731

Chicago's Gas Co. uses NATIONAL Control

Would You?

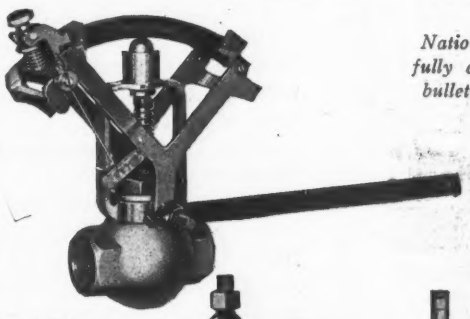
Let our engineers help in solving your damper control problems

Above is shown the home of the Peoples Gas Light & Coke Co. of Chicago, rising above Michigan Blvd. As did scores of other notable Chicago concerns, this company that supplies gas for millions of people specified National Damper Control that assures automatic, accurate, direct-acting, graduated control of dampers and stoker and blower drives, continuously maintained in proportion to boiler load and firing conditions.

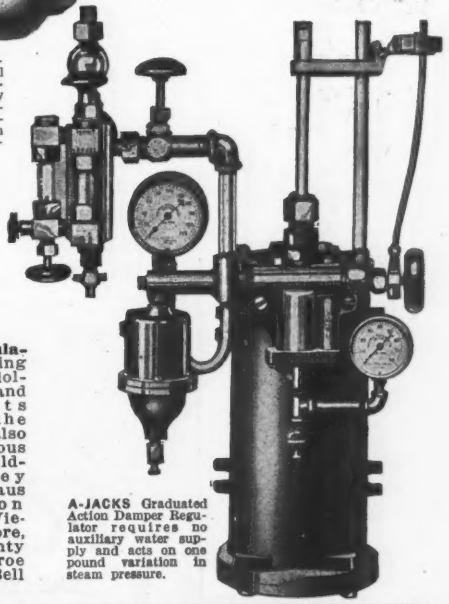
National Damper Control quickly pays for itself in fuel and labor saved —on any boiler, under any firing conditions—in hand, stoker, oil or pulverized fuel-fired plants.

National Regulator Co.
2301 Knox Ave. Chicago, Ill.

National Control fully described in bulletins. Write



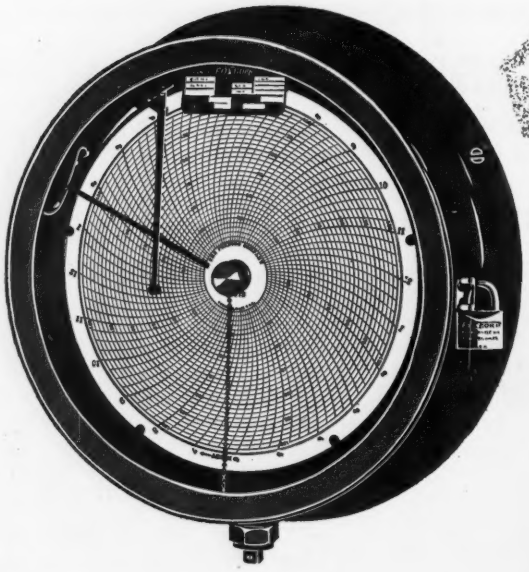
NATIONAL Balanced Control Valve, with **A-JACKS** is easily adjusted to maintain automatically fine, medium or coarse regulation.



A-JACKS Graduated Action Damper Regulator requires no auxiliary water supply and acts on one pound variation in steam pressure.

Known by Hundreds of Installations

National Regulators are saving thousands of dollars in large and small plants throughout the country. Used also in these famous new Chicago Buildings: Wrigley Buildings, Straus Building, Union League Club, Wieboldt Dept. Store, London Guaranty Building, Monroe Building, Bell Building.



The Cost–.5 per cent
The Saving–$26,000.00

Does Instrument Control of power plant temperatures and pressures bring about any coal economies?

The cost of Foxboro Instruments installed by a certain manufacturer, including maintenance, amounted to less than half of one per cent of his average annual fuel bill.

Resultant economies saved $26,000.00 the first year.

Perhaps you will be as surprised to learn, as was this manufacturer, how infinitesimal is the cost of Foxboro Instruments in comparison to the major cost of coal—how small is their cost in comparison with the savings they make possible.

The high quality, the guaranteed accuracy, the dependability of Foxboro Instruments for indicating, recording and controlling temperature and pressures is undisputed by conservative purchasers of power plant equipment. Write for Bulletin 96-1.

THE FOXBORO CO., INC.
Neponset Avenue, Foxboro, Mass., U. S. A.

New York Chicago Philadelphia Boston Pittsburgh
Cleveland Tulsa Rochester Atlanta
San Francisco Los Angeles Portland, Ore.

Peacock Brothers, Limited,
1605 Delorimier Avenue, Montreal, Canada
Sole British Representatives: Walker-Crosweller & Co.,
66 Dane's Inn House, Strand, London, W. C. 2.

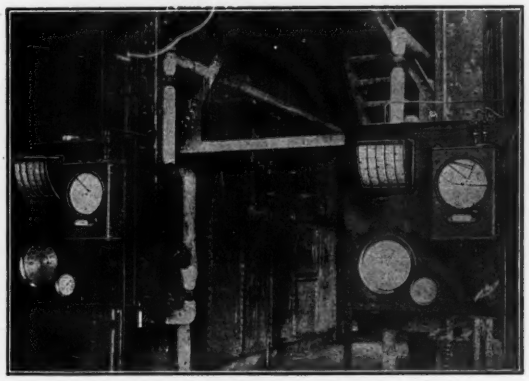
FOXBORO
REG. U. S. PAT. OFF.
THE COMPASS OF INDUSTRY

The New Chart Holder, Code No. 3-A, is the latest improvement in chart retention and is an exclusive Foxboro feature.

The chart slips into true center, is held securely and yet a twist of the tension head turns the chart to the correct time adjustment. Interchangeable with present chart holders.

Patent Applied For

Leading Steel Mills *use* Bailey Meters



Bailey Boiler Meters and Multi-Pointer Gages Insure Efficient Boiler Operation

A Few Prominent Steel Mills Using Bailey Meters

	Meters
Bethlehem Steel Company	211
Jones & Laughlin Steel Corp	106
Wheeling Steel Corporation	56
National Tube Company	44
Youngstown Sheet & Tube Co	43
American Steel & Wire Co	41
American Sheet & Tin Plate Co	40
Otis Steel Company	25
Weirton Steel Company	21
Alan Wood Iron & Steel Co	19
American Rolling Mill Co	17
Republic Iron & Steel Co.	
Trumbull Steel Company	
United Alloy Steel Corporation	
Crucible Steel Co. of America	
American Car & Foundry	

The largest and most important steel mills in the country use Bailey Equipment to ensure economical and efficient production and distribution of their steam. Bailey Boiler Meters and Multi-Pointer Gages are installed on all boilers so that the boiler operators will have all the necessary information to guide them in obtaining the desired capacity and best efficiency at all times.

The Bailey Boiler Meter records and integrates Steam Flow, records Air Flow and Flue Gas Temperature. The Steam Flow shows the rate of steam generation and the Air Flow records the air supplied for combustion. The relation between the Air Flow and Steam Flow records shows whether the correct amount of air is being supplied for combustion.

The Flue Gas Temperature Recorder makes a record of the average temperature of all the flue gases leaving the heating surface. This gives a check on the condition of the heating surface and baffles, as the presence of scale, soot or defective baffles is reflected in an increase of temperature.

Bailey Fluid Meters are used extensively for measuring the distribution of steam and water in steel plants. The superintendent of one large steel plant recently remarked that the installation of Bailey Fluid Meters on the steam lines to all departments had resulted in a very material reduction in their steam costs to the extent that the meters were paying for themselves every two weeks.

Bailey Gas Meters have been found very accurate and reliable for the measurement of coke oven gas. Several mills have them installed on each open hearth furnace.

Write for your copy of Bulletin No. 81, "The Heat Balance in Steam Power Plants."

BAILEY METERS

BAILEY METER CO.
2013 E.46TH ST. CLEVELAND, OHIO.
Bailey Meter Company Ltd. —— Montreal, Canada
Industrial Combustion Engineers Ltd. London, England

Three Famous WESTON *Electrodynamometer Instruments*

FAMOUS for their precision, design and workmanship, these portable A. C. and D. C. instruments are widely used as working standards. FAMOUS for their accuracy and dependability, these versatile, high grade portables are masterpieces of the instrument makers' art.

Moreover, this group of A. C. and D. C. instruments is complete, in a comprehensive list of ranges including A. C. and D. C. Ammeters, A. C. and D. C. Voltmeters, A. C. and D. C. Single Phase Wattmeters. They are the famous Weston electro dynamometer.

Model 310 a.c. and d.c. Single-Phase Wattmeter

Model 370 a.c. and d.c. Ammeter

Model 341 a.c. and d.c. Voltmeter

General Characteristics

Accuracy ¼ of 1%—

Hand calibrated scales, 5¼" long—knife edged pointers with mirror scales to facilitate close readings.

Efficiently shielded from the effects of external magnetic fields.

Very responsive—action of the pointer nearly aperiodic.

Negligible temperature errors.

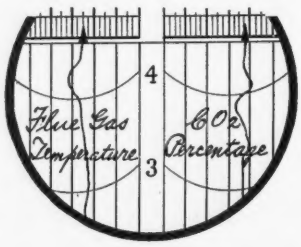
Accurate on commercial frequencies up to 133 cycles per second—can be supplied for higher frequencies when desired.

Independent of wave form.

Wattmeters have 100% current and 50% voltage overload capacity.

Weston Electrical Instrument Corporation
138 Weston Avenue, Newark, N. J.

THE BROWN INSTRUMENT CO., PHILADELPHIA, PA.



How much more would you save?

ENGINEERS figure that you can, conservatively speaking, save 13% of your fuel by checking stack temperatures. How much more can you save, if side by side—on one chart—you can compare continuous records of both CO_2 and your stack temperatures—and do this electrically?

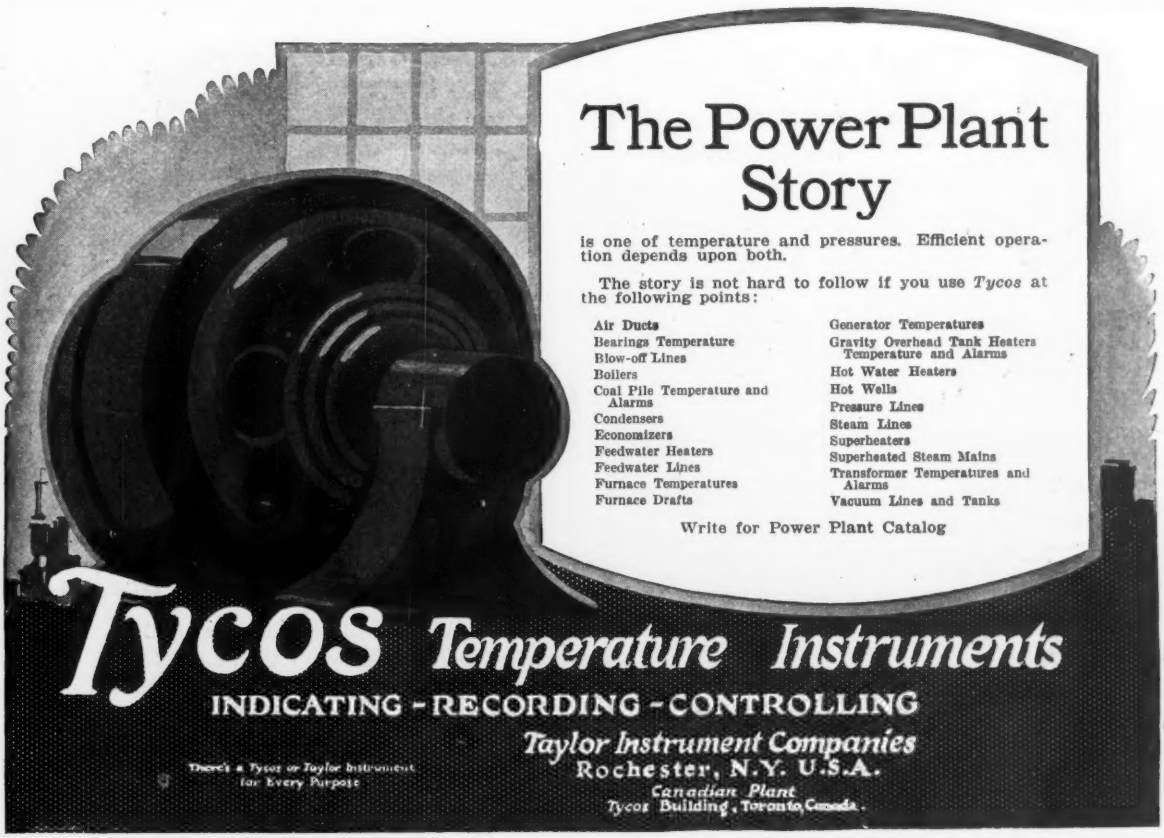
Two valuable booklets, entitled "Measuring CO_2 Electrically" and "Approval Deserves Weight," will be sent to you upon request. Write for them.

Address THE BROWN INSTRUMENT COMPANY, 4508 Wayne Avenue, Philadelphia, Pa., or one of our District Offices, in New York, Boston, Pittsburgh, Cleveland, Detroit, Chicago, Indianapolis, Birmingham, Houston, Tulsa, St. Louis, Denver, Salt Lake City, San Francisco, Los Angeles or Montreal.

Brown Electric CO_2 meters

Are You Seeking Sales Agencies or Representatives?

Maybe you need more representation for your products in certain parts of the country—in Oregon, Illinois, Ohio or elsewhere. High class agents or agencies can quickly be secured through the "Signboard Section." Place a message in it and it'll be read all over the country. You'll get quick action and results.



The Power Plant Story

is one of temperature and pressures. Efficient operation depends upon both.

The story is not hard to follow if you use *Tycos* at the following points:

- Air Ducts
- Bearings Temperature
- Blow-off Lines
- Boilers
- Coal Pile Temperature and Alarms
- Condensers
- Economizers
- Feedwater Heaters
- Feedwater Lines
- Furnace Temperatures
- Furnace Drafts
- Generator Temperatures
- Gravity Overhead Tank Heaters Temperature and Alarms
- Hot Water Heaters
- Hot Wells
- Pressure Lines
- Steam Lines
- Superheaters
- Superheated Steam Mains
- Transformer Temperatures and Alarms
- Vacuum Lines and Tanks

Write for Power Plant Catalog

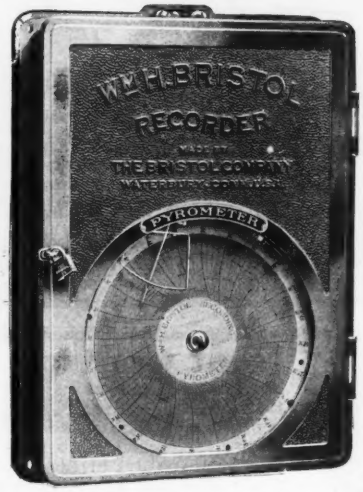
Tycos Temperature Instruments

INDICATING - RECORDING - CONTROLLING

There's a Tycos or Taylor Instrument for Every Purpose

Taylor Instrument Companies
Rochester, N.Y. U.S.A.
Canadian Plant
Tycos Building, Toronto, Canada

Modern Oil, Stoker and Pulverized Coal Firing



require both the accuracy at high temperatures and the dependability under all conditions, that are inherent in

TRADE MARK
BRISTOL'S Recording Pyrometers
REG. U. S. PAT. OFFICE.

It's the instantaneous, infallible indications they give of flue gas temperature that makes quick action possible to meet every variation before fuel waste mounts up.

It's the permanent record on the easily-read and readily-filed charts that make possible the close, comparative studies necessary to check efficiency and improve operating methods.

Catalogue O-1401 gives details on their frictionless system of recording, automatic cold-end compensator and the several models. Write for it.

BRISTOL'S
Recording Instruments

—a complete line to meet practically all power plant requirements, including Pressure, Vacuum, Draft, Temperature, Electricity, Motion, Speed, Humidity. Ask us for suggestions on improving economy. 36 years' experience at your service.

The Bristol Company *Waterbury, Connecticut*

FOR 36 YEARS — Ask Any Technical Engineer — MAKERS OF

BRISTOL'S RECORDING INSTRUMENTS

Branch Offices: Birmingham, Boston, Chicago, Detroit, New York, Pittsburgh, Philadelphia, St. Louis, San Francisco

Tried for 39 years

—and never found wanting

Surely the 1,500,000 Penberthy Injectors that have made good are positive proof that Penberthy Injectors will make good in your plant. In fact, no one thinks of "trying."

PENBERTHY PRODUCTS

PENBERTHY Automatic Injectors

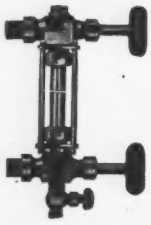
Just put them on your boilers and end all danger of shutdowns and low water levels.

Penberthy Injectors are themselves the highest type of boiler insurance.

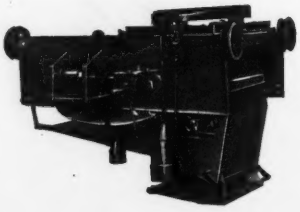
Carried by all jobbers. You should know the entire line of Penberthy Products for power plants. Write for illustrated literature.

"Safeguard" Automatic Water Gage

is as noted for reliability and the automatic protection it gives as the injector itself. Write.



Penberthy Injector Co.
1238 Holden Ave.,
Detroit, Mich.
Established 1886
Canadian Plant Windsor, Ont.
New York Office 71 Beekman St.



Right these Wrongs!

of faulty draft regulation, improper firings, soot, scale, leaks in baffles, holes in fires, etc., every one of which shows up promptly on the records of

RICHARDSON

Automatic Coal Scales

Weigh coal to individual boilers.
Weigh coal to PULVERIZERS.
Larries for weighing coal to a number of boilers.

RICHARDSON SCALE COMPANY
Passaic, New Jersey
New York Pittsburgh Boston Omaha Chicago

Know Power Control

Of Exceptional Value to Engineers and Power Executives

Measurement of Steam
Power Plant Cost Accounting
Republic CO_2 Recorders
Republic Pyrometers
Republic Draft Indicators
Republic Gas Meters
Republic Water Meters
Republic Coal Meters
Republic Boiler Meters

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Republic Flow Meters Co.
2224 Diversey Parkway CHICAGO, ILL.
Branch offices in 25 principal cities

REPUBLIC FLOW METERS

American S & B

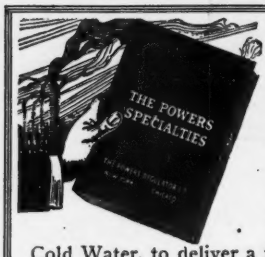
Instruments include, in addition to those illustrated, Gauge Testers, Temperature Controllers, Water Relief Valves, Engine Indicators, Feed Water Filters, Gauge Boards, etc. Write for catalog N-34.

American Schaeffer & Budenberg Corporation
Berry and South Fifth Sts.
Brooklyn, N. Y.

BACHARACH ENGINE INDICATORS

An Indicator of the highest type. Perfect adjustment in every part. Light but rugged construction. Minimum inertia, available for speeds up to 1200 R.P.M. and for pressures ranging from 2 lbs. to 1400 lbs. maximum. Applicable to all engines, steam, gas and oil. Can be furnished with automatic Power Integrator. Bulletin 260.

Bacharach Industrial Instrument Co.
7006 Bennett St. Pittsburgh, Pa.



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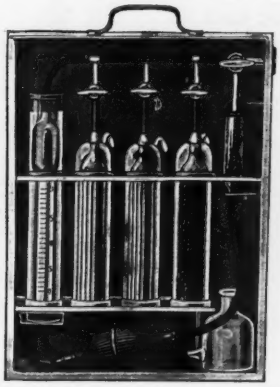
Systems of Temperature and Humidity Control for Offices, Workrooms, and Process Rooms. ¶Regulators to control Temperatures of Liquids, Gases and Air in Industrial Processes. ¶Thermostatic Regulators to control the mixing of Hot and Cold Air, Hot and Cold Water, Steam and Cold Water, to deliver a mixture at any temperature desired. Pressure Reducing Valves—High Pressure Steam Traps—Dial Indicating Thermometers—and the Powers Shower Mixer. ***Write for Bulletin.***

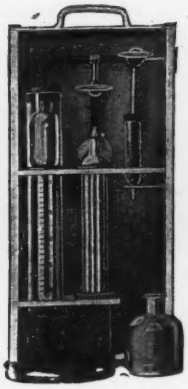
THE POWERS REGULATOR CO.
35 years of specialization in temperature control
2769 Greenview Ave., Chicago. Also New York, Boston, Toronto and 31 other offices. See your telephone directory. (3354)

Defender Improved (CO_2 O. & CO.) Flue Gas Analysers

for determining the percent of excess air and pounds of air per pound of Fuel used. The only positive and infallible method of determining the Furnace Efficiency.



Model A Three-Chamber Orsat Single Pipettes and Glass Cocks Price $35.00



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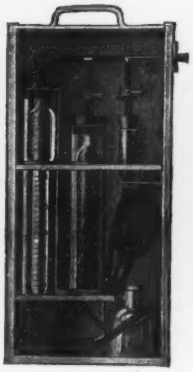

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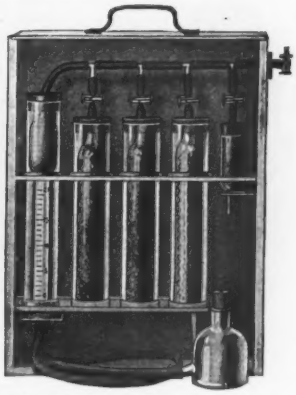

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The door slides out of the case from the top and is laid away out of the way when operating the Instrument.

The Glass Cocks and Pinch Cocks are the only two reliable methods of valve control used today in all Chemical Laboratories. You cannot work off makeshift devices on a Chemist and should not on an Engineer.

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In the production of Efficiency Instruments, Damper Regulators and appliances for Fuel and Labor saving in the Boiler Room.

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show a large number of additions and improvements to our general line of Automatic Damper Stoker and Fan Engine Regulators, Chronometer Valves, Balanced and Float Valves, Regulating Valves, Water Gauges and Gauge Cocks, Recording and Indicating Pyrometers, Recording and Indicating Thermometers, Recording and Indicating Draft Gauges, Recording Pressure and Vacuum Gauges, Portable sets of Draft Gauges, Portable Boiler Room Test Outfits, CO_2 Recorders and Analyzers, Instrument Cases and Control Boards.

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One Pound of Coal

of a certain grade will deliver heat enough to make a certain amount of steam in a given boiler. One-sixteenth of an inch of scale will cause at heat loss of 13%, or require for the same amount of steam 0.13 pounds more coal. In terms of tons, 13 out of every hundred burned is wasted. We **guarantee** a clean boiler when you use a Vater Hot Process Softener.

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If You Don't Check Your Coal

your plant is running wild. Accurate figures on coal burned and its steam-producing qualities are a necessity.

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tell how much each boiler burns. Prove the quality of the coal. Expose careless firing. Make coal economy certain. The records are **accurate** and dependable. Write for interesting literature.

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to clean the scale out of your boilers will mean loss and expense to you. Don't do it. A brick of Hawk-Eye Compound is always waiting to help you with this problem. In fact, if you have never used them, they have been waiting for 28 years to be of service to you. Don't wait any longer. Write to the Hawk-Eye Compound Co. (Not Inc.), Blue Island, Ill., for full particulars.

HAWK-EYE COMPOUNDS

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Upward Flow Zeolite Water Softeners
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George is trying to explain how it happened

IN THE power plant where George is a fireman there is a Reliance Safety Water Column on each boiler. The whistles are supposed to sound only once each day—when the columns are blown down to see that they are in good order.

If the whistles blow any other time, George has to explain why to the Chief Engineer. That's a tough job, for the Chief knows George must have been careless. And George knows he knows it. It will surprise no one, therefore, that this helps George to remember to watch the water gauges.

Reliance Columns are made for safety. And they do a good dependable job of it.

Would they improve conditions in your power house?

THE RELIANCE GAUGE COLUMN CO.
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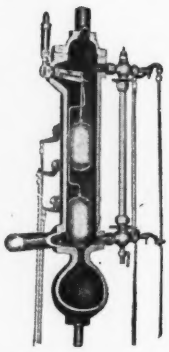

You can put an electric alarm on this column, along with the whistle, and keep a complete record of water levels. What happens at the plant when you're home for the night?

Reliance

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WATER
Softeners & Filters

Iron and Oil Removal Apparatus–Filtration Equipment–Water Conditioning Apparatus of every description

The Permutit Company
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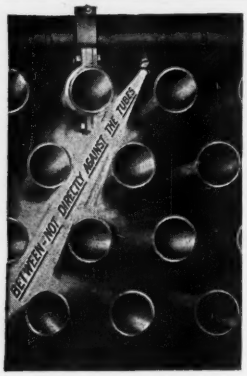


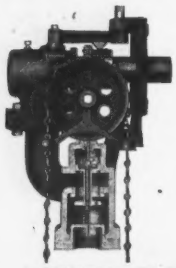
VULCAN *Diagonal* Method of Blowing

takes advantage of the diagonals formed by the tubes, in the staggered tube type of boilers, through which cleaning jets of steam can pass, scrubbing along the tubes clear to the bottom row, but never directly against them.

Special bulletins describing Vulcans for various types of boilers will be gladly sent on request.

Vulcan Soot Cleaner Co.
Vulcan Bldg., Dubois, Pa.

Efficient Soot Blowing—



was created with the Bayer Balanced Valve in Head type soot blower.

The blowing element does not turn until the balanced valve is wide open and the valve does not close till the element ceases to rotate, insuring full blowing force, properly directed through the entire arc.

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4060 Park Ave. St. Louis, Mo.

Marion Equipment

Soot Blowers for water tube boilers; for fire tube boilers; Hand Fire Stokers; Marion Scottdale Grates; Marion Interlocking Grates; Marion Rocking and Dumping Grates; Keystone Rocking and Dumping Grates; Portable Kiln Grates; Forced Draft Blowers; Boiler Fronts, etc.; Coal Mining Equipment; Coal Crushers, Coal and Coke Handling Machinery, Gas and Oil Engines.

Marion Machine, Foundry & Supply Company

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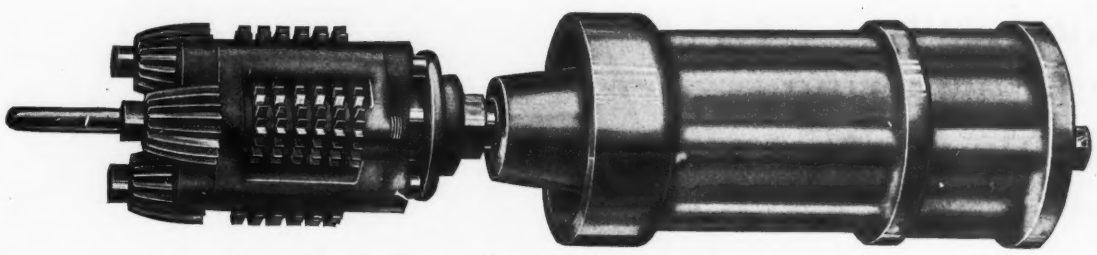
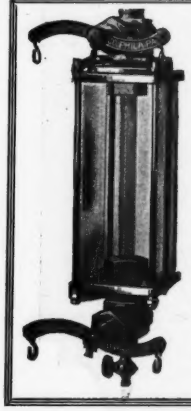
ROTO TUBE CLEANERS



Roto Heavy Duty Air-driven Tube Cleaner

FOR ALL TYPES OF TUBES

The Roto Company
HARTFORD, CONN.



Prevent Serious Losses

both in efficiency and the personnel of your plant. For over 25 years, engineers have been guarding their plants from inefficiency and their men from injury through the use of

"P. B. H." Steam Specialties

"P. B. H." Gauge Glass Protector shown at left attached to a "P. B. H." chain quick-closing water gauge prevents blindness, scalds or cuts when a gauge glass bursts. Easily installed on any size gauge. Better order before you experience such an accident. State distance between inside faces of rod plates on your gauge valve.

"P. B. H." Self-Closing Weighted Gauge Cock positively will not leak when closed. Instantly opened from the boiler room floor. When released, the weighted lever immediately closes the valve again. The wear-resisting metal valve pencil is of special design. When worn it can be replaced at a cost of a few cents. No regrinding ever required.

Prices Right

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Satisfaction Guaranteed

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Chase the Soot and Save Repairs by Using

PILLEY'S
Combination Flue Brush and Scraper

It is an efficient tool which removes the soot and scale and leaves the tubes shining like new.

The PILLEY is easy to operate. One turn of the handle contracts the scraper so that it will easily enter the tube. A turn in the opposite direction expands it to full size so that it comes in direct contact with the soot. The iron scraper breaks off the crust and the fine wire brush sweeps it out leaving the tube perfectly clean.

Pilley's Combination Flue Brush and Scraper not only saves repairs, it saves Coal, also.

Made in all sizes from 2 inches to 6 inches. Price, $1.00 per diameter inch. Your Jobber Sells Them.

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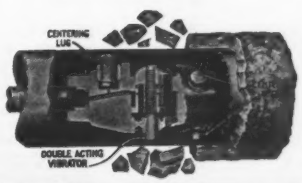
You can try it out on one boiler and if you don't like it, return it. Write for it today.

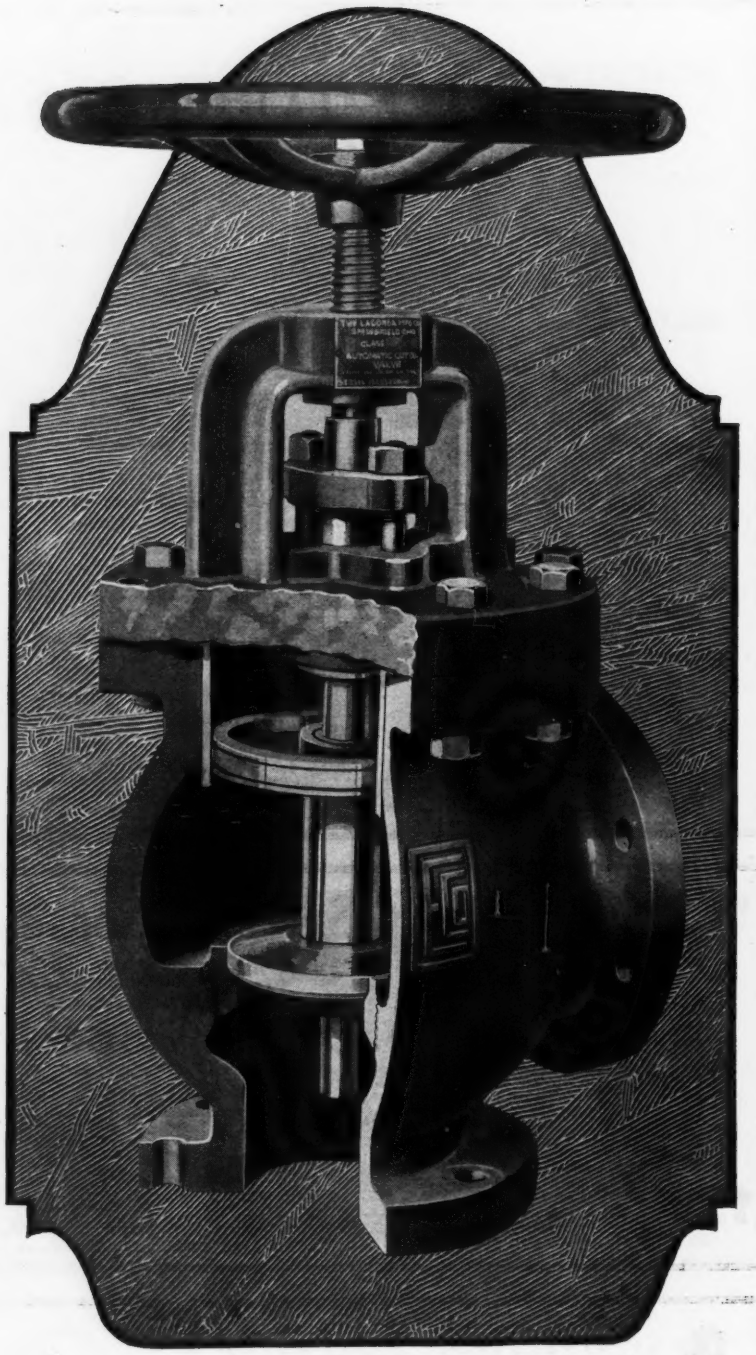
General Specialty Co.
70 Carroll St., Buffalo, N. Y.

Get the TORPEDO for fire tube boilers

It's efficient
It's durable
It's safe



The heavy, non-chattering trouble-proof non-return valve you see on so many boilers is a Lagonda Non-Return Valve



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S-1098

The 18th Annual Textbook *and* Reference Number of POWER PLANT ENGINEERING

will be the January 1, 1926, *Specialized Number on*

BOILER PLANT OPERATION

IN ITS constant endeavor to give helpful service to its readers, Power Plant Engineering will publish on January 1, 1926, its Annual Specialized Reference and Textbook Number.

These Annual January 1st Numbers have attained a height of usefulness that has caused hundreds of engineers to voluntarily write us that a single one of these numbers is worth the price of their year's subscription for 24 numbers.

In the next regular issue you receive, you will be presented with 120 pages of editorial text, data and illustrations that will bring the whole subject of "Boiler Plant Operation" up to the minute.

It will be a complete textbook of the most authoritative information on the subject. This 18th Annual Reference and Textbook Number will excel even its predecessors both in the timeliness of its subject and its comprehensive treatment.

This splendid number is now being prepared for printing, and there is every assurance that it will more than fulfill the expectations aroused by the outline of it published in these pages some time ago.

Many months of study and research on the part of the editorial staff have gone into the preparation of the "Boiler Plant Operation" Number. Power plant authorities of the highest standing have given the best of their thought and experience to its contents. Expense without stint has been given by its publishers to gathering the material and presenting it in the simplest and most useful form.

Manufacturers of every type of machinery, equipment and supplies will be shown in the advertising pages of this January 1st Specialized Number, the latest, most dependable and proven products that are available to the operation of every type and size of boiler plant and the power plant to which it furnishes steam.

What an opportunity this Textbook and Reference Number will present to power plant men to increase the authoritativeness of their opinions, to better their positions and to assume a new measure of leadership among their fellows and in the economics of the nation.

As power constantly increases in relative importance with other factors in business, industry, social and economic affairs of the nation, so every power plant man has greater opportunity for advancement.

To help to prepare its readers to embrace such opportunities is the purpose of Power Plant Engineering—and the "Boiler Plant Operation" Number is offered as a triple measure of such helpfulness presented in one great number for immediate use and ready reference.

All regular subscribers will receive it as a part of their yearly subscriptions.

In past years orders for extra copies of these January 1st Specialized Numbers have been received from consulting and designing engineers who are responsible for improvements in plants, and for the machinery, equipment and supplies used in them, as well as from many power companies for the use of their different department heads.

Years after date of publication urgent requests are received from subscribers for copies of these annual Specialized Numbers to replace copies that have been accidentally lost from their files.

Offering cash premiums rarely brings forth back copies to fill these requests, as they are evidently highly prized by every recipient and each edition is exhausted soon after publication.

To avoid disappointment it is suggested that you see that your annual subscription is entered and extra copies ordered at once so that a sufficiently large edition may be printed.

The annual subscription to Power Plant Engineering, 24 issues, including the January 1, Specialized Number, is $2.00 a year. Extra copies of the January 1 Number on "Boiler Plant Operation," are 50 cents each, postage prepaid.

Send remittances and orders for both annual subscriptions and extra copies direct to the Technical Publishing Company, 537 South Dearborn St., Chicago.

Printing on the January 1, 1926, "Boiler Plant Operation" Number commences on December 16, after which time the edition cannot be enlarged. Therefore we urge you to consider your requirements for executives or special reference use and

Order Extra Copies at Once

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Stearns Conveyor Co., The, Cleveland, Ohio.
Stephens-Adamson Mfg. Co., Aurora, Ill.
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Webster Mfg. Co., The, Chicago.
Weller Mfg. Co., Chicago, Ill.

COAL BUNKERS, CAST IRON, CATENARY.
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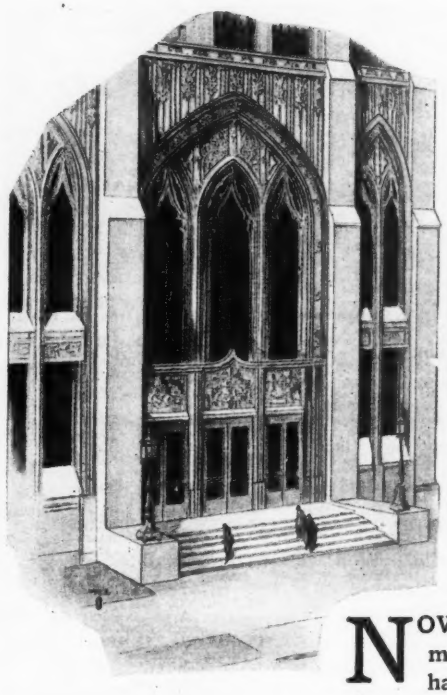

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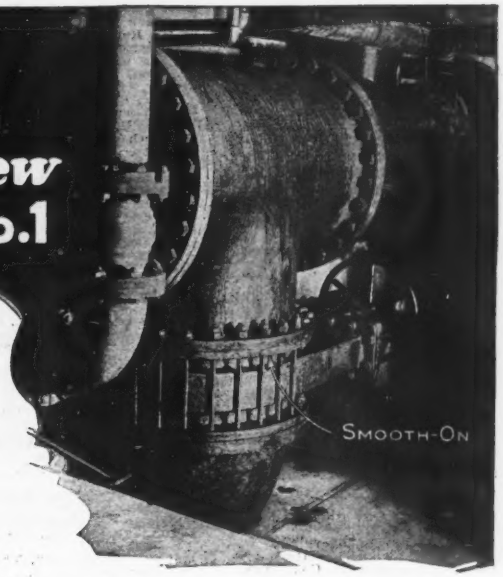

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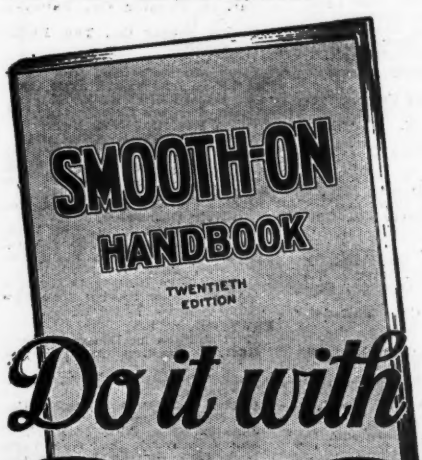

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Vacuum Oil Co., New York.

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Power Specialty Co., New York.

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Griscom-Russell Co., New York.
Patterson-Kelley, New York.
Powers Regulator Co., Chicago.
Ross Heater & Mfg. Co., Buffalo.

HEATERS, OIL.
Power Specialty Co., New York.
Ross Heater & Mfg. Co., Buffalo.

HEATING DEVICES.
Cutler-Hammer Mfg. Co., The, Milwaukee.

HOISTS.
Beaumont Co., R. H., Philadelphia.
Stearns Conveyor Co., The, Cleveland, Ohio.
Stephens-Adamson Mfg. Co., Aurora, Ill.

HOISTS, SKIP.
Beaumont Co., R. H., Philadelphia.
Stearns Conveyor Co., The, Cleveland, Ohio.
Stephens-Adamson Mfg. Co., Aurora, Ill.

HOPPERS AND BINS, COAL AND ASH.
Allen-Sherman-Hoff Co., The, Philadelphia, Pa.
Beaumont Mfg. Co., Philadelphia, Pa.
Brady Conveyors Corp., Chicago.
Combustion Engineering Corp., New York, N. Y.
Frederick Iron & Steel Co., Frederick, Md.

HOSE.
New York Belting & P'k'g. Co., New York.
Quaker City Rubber Co., Phila.
United States Rubber Co., New York, N. Y.

HYDRAULIC MACHINERY.
Bethlehem Steel Co., Inc., Bethlehem, Pa.

HYDROMETERS.
Foxboro Co., Inc., The, Foxboro, Mass.
Taylor Instrument Co's., Rochester, N. Y.

HYGRODEIKS.
Taylor Instrument Co's., Rochester, N. Y.

ICE MAKING AND REFRIGERATING MACHINERY.
Ingersoll-Rand Co., New York.
Vilter Mfg. Co., Milwaukee, Wis.

INDICATORS, ENGINE.
American Schaeffer & Budenberg Corp., Brooklyn, N. Y.
Robertson & Sons, James L., New York, N. Y.

INJECTORS AND INSPIRATORS.
Penberthy Injector Co., Detroit.
Schutte & Koerting Co., Phila.
Sherwood Mfg. Co., Buffalo, N. Y.
Superheater Co., The, New York.

INSTRUMENTS, ELECTRICAL.
Brown Instrument Co., The, Philadelphia.
Weston Electrical Instrument Corp., Newark, N. J.

INSTRUMENTS, INDICATING.
Weston Electrical Instrument Corp., Newark, N. J.

INSULATING MATERIAL.
Carey Co., The Philip, Cincinnati, Ohio.
Cutler-Hammer Mfg. Co., The, Milwaukee.
Johns-Manville, Inc., New York.
Quigley Furnace Specialties Co., Inc., New York.

JOINTS, EXPANSION.
Badger & Sons Co., E. B., Boston, Mass.
Griscom Russell Co., New York.
Howard Iron Works, Buffalo.
Kelly & Jones Co., The, Greensburg, Pa.
Mogul Machine Co., Philadelphia.
Ross Heater & Mfg. Co., Buffalo.
United States Rubber Co., New York, N. Y.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

LADDER STEPS, STEEL.
Irving Iron Works, Co., Long Long Island City, N. Y.

LAMPS, ELECTRIC.
General Electric Co., Schenectady, N. Y.

LININGS, COAL BUNKER.
Wailes Dove-Hermiston Corp., New York.

LININGS, FURNACE.
General Refractories Co., Philadelphia.

LOADERS AND UNLOADERS.
Link-Belt Co., Chicago, Ill.

LUBRICANTS.
Cook's Sons, Inc., Adam, New York, N. Y.
Dearborn Chemical Co., Chicago.
Dixon Crucible Co., Jos., Jersey City, N. J.
Harris Oil Company, The A. W., Providence, R. I.
Keystone Lubricating Co., Phila.
Ohio Grease Co., Loudonville, O.
Standard Oil Co., (Indiana), Chicago, Ill.
Tide Water Oil Sales Corp., New York.
Vacuum Oil Co., New York.

LUBRICATORS.
Cook's Sons, Inc., Adam, New York, N. Y.
Greene, Tweed & Co., New York.
Hills-McCanna Co., Chicago, Ill.
Keystone Lubricating Co., Phila.
Lunkenheimer Co., Cincinnati.
Manzel Bros. Co., Buffalo, N. Y.
Nugent Co., Wm. W., Chicago.
Ohio Grease Co., Loudonville, O.
Powell Co., The Wm., Cincinnati.
Sherwood Mfg. Co., Buffalo, N. Y.
Stephenson Mfg. Co., Albany.
Williams Valve Co., D. T., Cincinnati, Ohio.

LUBRICATORS, FORCED FEED.
Greene, Tweed & Co., New York.
Hills-McCanna Co., Chicago, Ill.
Lunkenheimer Co., Cincinnati.
Manzel Bros. Co., Buffalo, N. Y.
Sherwood Mfg. Co., Buffalo, N. Y.

MECHANICAL DRAFT APPARATUS.
Coppus Engineering Corp., Worcester, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.
Wing Mfg. Co., L. J., New York.

METERS, AIR AND GAS.
Bailey Meter Co., Cleveland, O.
Republic Flow Meters Co., Chicago, Ill.

METERS, BOILER.
Bailey Meter Co., Cleveland, O.
C. J. Mfg. Co., Philadelphia, Pa.
Republic Flow Meters Co., Chicago.
Yarnall-Waring Co., Philadelphia, Pa.

METERS, COAL.
Bailey Meter Co., Cleveland, O.
C. J. Mfg. Co., Philadelphia.
Republic Flow Meters Co., Chicago, Ill.
Richardson Scale Co., Passaic.

METERS, FEED WATER.
Bailey Meter Co., Cleveland, O.
Hoppes Mfg. Co., Springfield, O.
Republic Flow Meters Co., Chicago, Ill.
Simplex Valve & Meter Co., Philadelphia, Pa.
Worthington Pump & Machinery Corp., New York, N. Y.
Yarnall-Waring Co., Philadelphia, Pa.

METERS, STEAM.
Bailey Meter Co., Cleveland, O.
Republic Flow Meters Co., Chicago, Ill.

METERS, WATER.
Bailey Meter Co., Cleveland.
Hoppes Mfg. Co., Springfield, O.
Republic Flow Meters Co., Chicago, Ill.

NOZZLES FOR ALL PURPOSES.
Bacharach Ind. Instrument Co., Pittsburgh, Pa.
Cooling Tower Co., Inc., The, New York.
Schutte & Koerting Co., Phila.
Spray Engineering Co., Boston.
Uehling Instrument Co., Paterson, N. J.

OIL AND GREASE CUPS.
Cooks Sons, Inc., Adam, New York, N. Y.
Keystone Lubricating Co., Phila.
Lonergan Co., J. E., Philadelphia, Pa.
Ohio Grease Co., Loudonville, O.
Penberthy Injector Co., Detroit.
Powell Co., The Wm., Cincinnati.
Sherwood Mfg. Co., Buffalo.
Williams Valve Co., D. T., Cincinnati, Ohio.

OIL BURNING EQUIPMENT.
Bethlehem Shipbuilding Corp., Bethlehem, Pa.
Combustion Engineering Corp., New York.
Schutte & Koerting Co., Phila.

OIL CIRCUIT BREAKERS
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

OIL PURIFIERS.
Nugent Co., Wm. W., Chicago.

OL PURIFIERS, CENTRIFUGAL.
De Laval Steam Turbine Co., Trenton, N. J.

OIL SEPARATORS.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., New York.
Nugent Co., Wm. W., Chicago.
Wright-Austin Co., Detroit.

OIL TANKS.
Manzel Bros Co., Buffalo, N. Y.
Nugent Co., Wm. W., Chicago.

OILING SYSTEMS.
Burt Mfg. Co., The, Akron, O.
Hills-McCanna Co., Chicago, Ill.
Nugent Co., Wm. W., Chicago.

OILS, LUBRICATING.
Cook's Sons, Inc., Adam, New York, N. Y.
Dearborn Chemical Co., Chicago.
Harris Oil Company, The A. W., Providence, R. I.
Standard Oil Co. (Indiana), Chicago, Ill.
Tide Water Oil Sales Corp., New York, N. Y.
Vacuum Oil Co., New York.

PACKING, ASBESTOS.
Garlock Packing Co., Palmyra, N. Y.
Gasket Supply Co., The, Philadelphia.
United States Rubber Co., New York.

PACKING, CENTRIFUGAL PUMP.
Garlock Packing Co., Palmyra, N. Y.
United States Rubber Co., New York, N. Y.

PACKING, METALLIC.
Conneaut Packing Co., The, Conneaut, O.
Crane Packing Co., Chicago, Ill.
Eureka Packing Co., New York.
Garlock Packing Co., Palmyra, N. Y.
Gasket Supply Co., The, Philadelphia.
Huhn Mfg. Co., New York.
Power Specialty Co., New York.

PACKING, METALLIC FOR CONDENSER TUBES.
Crane Packing Co., Chicago, Ill.
Huhn Mfg. Co., New York.

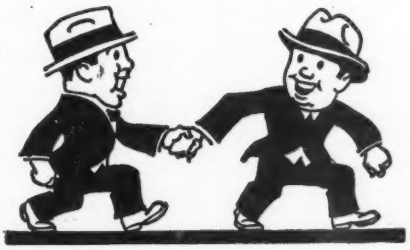
PACKING, PISTON AND ROD.
Crane Packing Co., Chicago, Ill.
Eureka Packing Co., New York.
Garlock Packing Co., Palmyra, N. Y.
Goetze Gasket & Packing Co., New Brunswick, N. J.
Greene, Tweed & Co., New York.
Johns-Manville, Inc., New York.
New York Belting & P'k'g. Co., New York.
Quaker City Rubber Co., Phila.
United States Rubber Co., New York, N. Y.

PACKING, SHEET.
Eureka Packing Co., New York.
Garlock Packing Co., Palmyra, N. Y.
Gasket Supply Co., The, Philadelphia.
Goetze Gasket & Packing Co., New Brunswick, N. J.
Jenkins Bros., New York, N. Y.
Johns-Manville, Inc., New York.
New York Belting & P'k'g. Co., New York.
Quaker City Rubber Co., Phila.
Robertson & Sons, Jas. L., New York.
United States Rubber Co., New York, N. Y.

PACKING, VALVE STEM.
Garlock Packing Co., Palmyra, N. Y.
Gasket Supply Co., The, Philadelphia.
New York Belting & P'k'g. Co., New York.
Quaker City Rubber Co., Phila.
United States Rubber Co., New York, N. Y.

PAINT, ANTI-CORROSIVE.
Wailes Dove-Hermiston Corp., New York.

PAINT, FLOOR.
Wailes Dove-Hermiston Corp., New York.



Hand in Hand advertising and lower sales cost

It is to the buyer's interest to know that goods are *sold economically* for he pays the cost of selling just as he pays for the cost of manufacturing.

That's why more and more buyers are scrutinizing sales methods of manufacturers, for they know that excessive sales costs mean either higher prices or shrinking quality.

The seller who clings to antiquated, expensive methods of selling is no more entitled to patronage than one who runs an out-of-date factory.

Machinery has cut costs and standardized products in manufacturing and the *machinery of advertising* is accomplishing similar benefits in selling, for advertising in publications such as this one, is not an added expense, but an improved means of communication that takes the place of slower and more costly methods.

These are demonstrated facts and thinking buyers are recognizing the advantage to them of encouraging progressive, economical *sales* methods, such as have been adopted by the companies represented in the advertising pages of this journal.

The advertising these companies are doing not only cuts the cost of selling, but it increases production volume, standardizes quality, and is a guarantee of good faith.

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Grinnell Co., Inc., Providence.
Mogul Machine Co., Philadelphia.
National Pipe Bending Co., The, New Haven, Conn.
Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.

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Grinnell Co., Inc., Providence.
Mogul Machine Co., Philadelphia.
National Pipe Bending Co., The, New Haven, Conn.
Superheater Co., The, New York.

PIPE COVERINGS.
Johns-Manville, Inc., New York.
Ric-Wil Co., The, Cleveland.

PIPE CUTTERS.
Toledo Pipe Threading Mach. Co., The, Toledo, O.
Williams Tool Corp., Erie, Pa.

PIPE FITTINGS.
Grinnell Co., Inc., Providence.

PIPE THREADING MACHINES.
Toledo Pipe Threading Mach. Co., The, Toledo, O.
Williams Tool Corp., Erie, Pa.

PIPE, WOOD.
Ric-Wil Co., The, Cleveland.

PIPE, WROUGHT STEEL.
National Tube Co., Pittsburgh.

PIPING.
National Tube Co., Pittsburgh.

PIPING CONTRACTING MANUFACTURERS.
Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.

PLANIMETERS.
Bristol Co., The, Waterbury.
Foxboro Co., Inc., The, Foxboro.
Robertson & Sons, Jas. L., New York.

PLATE STEEL CONSTRUCTION.
Littleford Bros., Cincinnati.

PORTABLE CONVEYORS.
Weller Mfg. Co., Chicago, Ill.

POWDERED COAL EQUIPMENT.
Bethlehem Steel Co., Inc., Bethlehem, Pa.
Combustion Engineering Corp., New York, N. Y.
Fuller-Lehigh Co., Fullerton, Pa.
Furnace Engineering Co., New York.

POWER TRANSMITTING MACHINERY.
Webster Mfg. Co., The, Chicago.

PREHEATER AND HEAT EXCHANGERS.
Patterson-Kelley Co., The, New York.

PULLEYS, FRICTION CLUTCH.
Link-Belt Co., Chicago, Ill.

PULVERIZERS, COAL.
American Pulverizer Co., St. Louis.
Bethlehem Steel Co., Inc., Bethlehem, Pa.
Combustion Eng'r'g. Corp., N. Y.
Erie City Iron Wks., Erie, Pa.
Fuller-Lehigh Co., Fullerton, Pa.
Furnace Engineering Co., New York.
Pennsylvania Crusher Co., Philadelphia.
Weller Mfg. Co., Chicago.

PULVERIZERS, LIMESTONE.
Pennsylvania Crusher Co., Philadelphia.

PUMPING SYSTEMS, AIR LIFT.
Ingersoll-Rand Co., New York.

PUMPS, BOILER FEED.
American Steam Pump Co., Battle Creek, Mich.
Bethlehem Shipbuilding Corp., Bethlehem, Pa.
Coppus Engineering Corp., Worcester, Mass.
Dean Bros. Co., Indianapolis.
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Fairbanks, Morse & Co., Chicago.
Frederick Iron & Steel Co., Frederick, Md.
Ingersoll-Rand Co. (Cameron Steam Pump Wks., A. S.), New York.
Kingsford Fdry. & Mach. Wks., Oswego, N. Y.
Lecourtenay Co., Newark, N. J.
Manistee Iron Works, Manistee.
Moore Steam Turbine Corp., Wellsville, N. Y.
Platt Iron Works, Dayton, O.
Superheater Co., The, New York.
Warren Steam Pump Co., Warren, Mass.
Worthington Pump & Machinery Corp., New York, N. Y.

PUMPS, CENTRIFUGAL.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Steam Pump Co., Battle Creek, Mich.
Bethlehem Shipbuilding Corp., Bethlehem, Pa.
Coppus Engineering Corp., Worcester, Mass.
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Fairbanks Morse & Co., Chicago.
Frederick Iron & Steel Co., Frederick, Md.
Ingersoll-Rand Co. (Cameron Steam Pump Wks., A. S.), New York.
Kingsford Fdry. & Mach. Wks., Oswego, N. Y.
Lecourtenay Co., Newark, N. J.
Manistee Iron Works, Manistee.
Moore Steam Turbine Corp., Wellsville, N. Y.
Northern Equipment Co., Erie.
Platt Iron Works, Dayton, O.
Terry Steam Turbine Co., Hartford, Conn.
Warren Steam Pump Co., Warren, Mass.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.
Worthington Pump & Machinery Corp., New York, N. Y.
Yeomans Bros. Co., Chicago, Ill.

PUMPS, DEEP WELL.
American Steam Pump Co., Battle Creek, Mich.
Fairbanks, Morse & Co., Chicago.
Lecourtenay Co., Newark, N. J.
Northern Equipment Co., Erie.
Platt Iron Works, Dayton, O.

PUMPS, ELECTRIC.
American Steam Pump Co., Battle Creek, Mich.
Dean Bros. Co., Indianapolis.
Platt Iron Works, Dayton, O.
Warren Steam Pump Co., Warren, Mass.
Yeomans Bros. Co., Chicago, Ill.

PUMPS, ELEVATOR AND FIRE.
American Steam Pump Co., Battle Creek, Mich.
Dean Bros. Co., Indianapolis.
De Laval Steam Turbine Co., Trenton, N. J.
Lecourtenay Co., Newark, N. J.
Manistee Iron Works, Manistee, Mich.
Warren Steam Pump Co., Warren, Mass.
Yeomans Bros. Co., Chicago, Ill.

PUMPS, HYDRAULIC PRESSURE.
American Steam Pump Co., Battle Creek, Mich.
Dean Bros. Co., Indianapolis.
Platt Iron Works, Dayton, O.
Warren Steam Pump Co., Warren, Mass.

PUMPS, JET.
Elliott Co., Jeannette, Pa.
Manistee Iron Works, Manistee, Mich.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

PUMPS, OIL.
Bethlehem Shipbuilding Corp., Ltd., Bethlehem, Pa.
Lonergan Co., J. E., Phila.
Manzel Bros. Co., Buffalo, N. Y.
Nugent Co., Wm. W., Chicago.
Penberthy Injector Co., Detroit.
Warren Steam Pump Co., Warren, Mass.

PUMPS, POWER.
Bethlehem Shipbuilding Corp., Bethlehem, Pa.
Fairbanks, Morse & Co., Chicago.
Lecourtenay Co., Newark, N. J.
Platt Iron Works, Dayton, O.
Warren Steam Pump Co., Warren, Mass.
Worthington Pump & Machinery Corp., New York, N. Y.

PUMPS, ROTARY.
Lecourtenay Co., Newark, N. J.
Manistee Iron Works, Manistee, Mich.
Platt Iron Works, Dayton, O.

PUMPS, STEAM.
Dean Hill Pump Co., Anderson, Ind.

PUMPS, TURBINE.
Bethlehem Shipbuilding Corp., Bethlehem, Pa.
Moore Steam Turbine Corp., Wellsville, N. Y.
Standard Turbine Corp., Scio, N. Y.

PUMPS, VACUUM.
American Steam Pump Co., Battle Creek, Mich.
Dean Bros. Co., Indianapolis.
Frederick Iron & Steel Co., Frederick, Md.
Ingersoll-Rand Co., New York.
Lecourtenay Co., Newark, N. J.
Manistee Iron Works, Manistee, Mich.
Warren Steam Pump Co., Warren, Mass.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

PUMPS, WATERWORKS.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Bethlehem Steel Co., Inc., Bethlehem, Pa.
Fairbanks, Morse & Co., Chicago.
Lecourtenay Co., Newark, N. J.
Manistee Iron Works, Manistee.
Moore Steam Turbine Corp., Wellsville, N. Y.
Murray Iron Works Co., Burlington, Iowa.
Platt Iron Works, Dayton, O.
Terry Steam Turbine Co., Hartford, Conn.
Warren Steam Pump Co., Warren, Mass.

PURIFIERS, BOILER FEED.
Hoppes Mfg. Co., Springfield, O.
Sims, Co., The Erie, Pa.

PURIFIERS, STEAM.
Andrews-Bradshaw Co., The, Pittsburgh.

PYROMETERS.
Bristol Co., The, Waterbury.
Brown Instrument Co., The, Philadelphia, Pa.
Defender Automatic Regulator Co., St. Louis.
Republic Flow Meters Co., Chicago, Ill.
Taylor Instrument Co's., Rochester, N. Y.
Uehling Instrument Co., Paterson, N. J.

QUENCHERS, ASH.
Allen-Sherman-Hoff Co., The, Philadelphia, Pa.

RECORDERS, LIQUID LEVEL.
Brown Instrument Co., The, Philadelphia.

RECORDING INSTRUMENTS.
Bacharach Ind. Instrument Co., Pittsburgh, Pa.
Bristol Co., The, Waterbury.
Brown Instrument Co., The, Philadelphia, Pa.
Defender Automatic Regulator Co., St. Louis.
Foxboro Co., Inc., The, Foxboro.
Uehling Instrument Co., Paterson, N. J.

REDUCING WHEELS.
Nugent Co., Wm. W., Chicago.
Robertson & Sons, Jas. L., N. Y.

REFRACTORIES.
Botfield Refractories Co., Philadelphia, Pa.
General Refractories Co., Philadelphia, Pa.
Harbison-Walker Refractories Co., Pittsburgh.
Obermayer Co., The S., Chicago.
Pilbrico Jointless Firebrick Co., Chicago.

REGULATORS, DAMPER.
Atlas Valve Co., Newark, N. J.
Brown Instrument Co., The, Philadelphia, Pa.
Defender Automatic Regulator Co., St. Louis.
d'Este Co., Julian, Boston.
Huyette Co., Inc., The Paul B., Philadelphia, Pa.
Mason Regulator Co., Boston.
National Regulator Co., Chicago.
Powers Regulator Co., Chicago.
Robertson & Sons, Jas. L., New York.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Wing Mfg. Co., L. J., New York.

REGULATORS, FAN ENGINE.
Atlas Valve Co., Newark, N. J.

REGULATORS, FEED WATER.
Chaplin-Fulton Mfg. Co., Pittsburgh.
Cleveland Feed Water Regulator Co., The, Cleveland, O.
Northern Equipment Co., Erie.
Powers Regulator Co., The, Chicago, Ill.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
"S-C" Regulator Mfg. Co., The, Fostoria, Ohio.
Squires Co., The C. E., Cleveland, Ohio.
Wing Mfg. Co., L. J., New York.
Wright-Austin Co., Detroit.

REGULATORS, PRESSURE.
Atlas Valve Co., Newark, N. J.
Boylston Steam Specialty Co., Chicago.
Davis Regulator Co., G. M., Chicago, Ill.
Dean Bros. Co., Indianapolis.
d'Este Co., Julian Boston.
Fisher Governor Co., The, Marshalltown, Iowa.
Illinois Engineering Co., Chicago.
Mason Regulator Co., Boston.
Powers Regulator Co., The, Chicago, Ill.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Squires Co., The, C. E., Cleveland.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.
Taylor Instrument Co's., Rochester, N. Y.

REGULATORS, TEMPERATURE.
Atlas Valve Co., Newark, N. J.
Bristol Co., The, Waterbury.
Brown Instrument Co., The, Philadelphia.
d'Este Co., Julian, Boston.
Foxboro Co., Inc., The, Foxboro.
Powers Regulator Co., Chicago.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Sarco Co., Inc., New York, N. Y.
Taylor Instrument Co's., Rochester, N. Y.

REGULATORS, VOLTAGE.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

RESEATING MACHINES.
Leavitt Machine Co., Orange, Mass.

RETURN TRAPS.
Bundy Steam Trap Co., Nashua.
d'Este Co., Julian, Boston.

ROPE DRESSING AND PRESERVATIVE.
Cling-Surface Co., Buffalo, N. Y.
Stephenson Mfg. Co., Albany.

ROPE, WIRE.
American Steel & Wire Co., Chicago and New York.

RUST PREVENTIVES.
Dearborn Chemical Co., Chicago.

SCALE REMOVERS (Mechanical)
General Specialty Co. The,, Buffalo, N. Y.
Lagonda Mfg. Co., Springfield, Ohio.
Liberty Mfg. Co., Pittsburgh.
Pierce Co., The Wm. B., Buffalo, N. Y.
Roto Co., The, Hartford, Conn.

SCREENS.
Link-Belt Co., Chicago, Ill.
Stearns Conveyor Co., The, Cleveland, Ohio.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.
Weller Mfg. Co., Chicago, Ill.

SEPARATORS AND EXTRACTORS, STEAM AND OIL.
Andrews-Bradshaw Co., Pittsburgh.
d'Este Co., Julian, Boston.
Direct Separator Co., Inc., The, Syracuse, N. Y.
Elliott Company, Jeannette, Pa.
Hoppes Mfg. Co., Springfield, O.
Illinois Engineering Co., Chicago.
Murray Iron Works Co., Burlington, Iowa.
National Pipe Bending Co., The, New Haven, Conn.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Robertson & Sons, J. L., N. Y.
Sims Co., The, Erie, Pa.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.
Williams Valve Co., D. T., Cincinnati, Ohio.
Wright-Austin Co., Detroit.

SEPARATORS, STEAM AND AIR.
Griscom-Russell Co., New York.

SEWAGE EJECTORS.
Yeomans Bros. Co., Chicago, Ill.

SHAFTING.
National Tube Co., Pittsburgh.

SLUICING SYSTEMS, ASH.
Allen-Sherman-Hoff Co., The, Philadelphia, Pa.

SMOKE FLUES.
Littleford Bros, Cincinnati.

SOOT BLOWERS.
Bayer Co., The, St. Louis, Mo.
Huyette Co., Inc., The Paul B., Philadelphia, Pa.
Marion Mach., Fdry. & Supply Co., Marion, Ind.
Sherwood Mfg. Co., Buffalo.
Vulcan Soot Cleaner Co., Du Bois, Pa.

SPRAY AIR WASHERS.
Badger & Sons Co., E. B., Boston, Mass.
Cooling Tower Co., Inc., The, New York, N. Y.
Spray Engineering Co., Boston.

SPRAY COOLING SYSTEMS.
Badger & Sons Co., E. B., Boston, Mass.
Cooling Tower Co., Inc., The, New York, N. Y.
Spray Engineering Co., Boston.

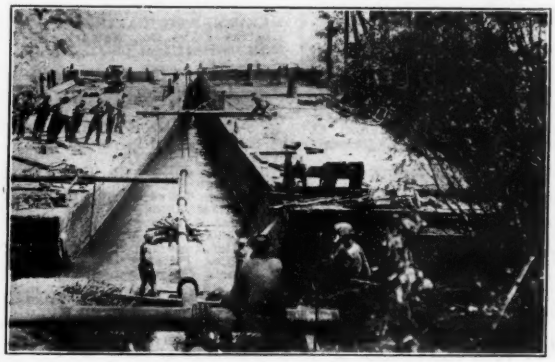
SPROCKET RIMS.
Babbitt Steam Specialty Co., New Bedford, Mass.

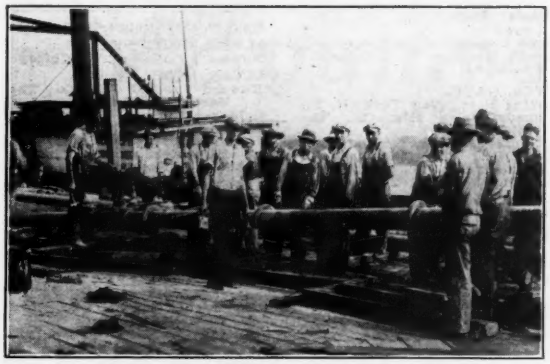
STACKS, METAL.
Littleford Bros., Cincinnati, O.

STAIR TREAD, NON-SLIPPING.
Irving Iron Works Co., Long Island City, N. Y.
Scully Steel & Iron Co., Chicago.

STEAM TRAPS.
American Schaeffer & Budenberg Corp., Brooklyn, N. Y.
Armstrong Machine Wks., Three Rivers, Mich.
Boylston Steam Specialty Co., Chicago.
Bundy Steam Trap Co., Nashua.
Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston.
Fisher Governor Co., The, Marshalltown, Iowa.
Golden-Anderson Valve Specialty Co., Pittsburgh.
Illinois Engineering Co., Chicago.
Kelly & Jones Co., The, Greensburg, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Patterson-Kelley, New York.
Powers Regulator Co., Chicago.

Under the Ohio River





The Louisville Gas and Electric Company have just run a pipe line under the Ohio River, coated with

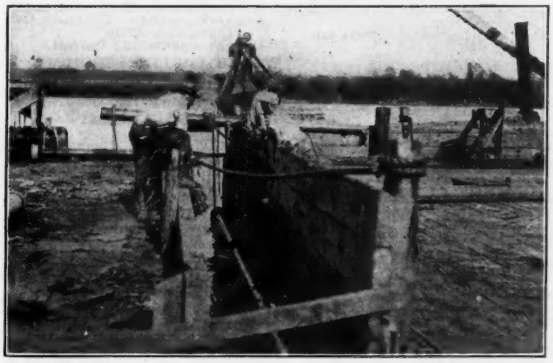
NO-OX-ID
IRON-OX-RUST
TRADE MARK
The Original Rust Preventive

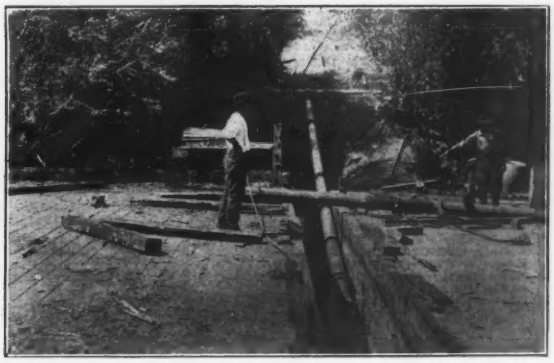
This rust preventive has made such an excellent record on their lines in years past that they used it without question. One coating was rubbed in thoroughly and the next applied liberally as an added protection for this line must "stay put" for years to come.

For service on pipe lines, on refrigerating equipment, coal bunkers, tanks, boiler fronts, structural steel, exhaust lines, NO-OX-ID has proven its value for many years.

Manufacturers of automobiles, trucks, farm implements, pipe ball bearings, adding machines, tools, and many other commodities, use it to insure their products reaching the consumer without rust.

Over 12,672,000 feet of pipe line has been coated with NO-OX-ID since June, 1924.





NO-OX-ID is easy to apply—very inexpensive, long lasting, and it prevents rust absolutely.

Talk over your rust problem with your DEARBORN Salesman or write us, describing equipment you desire to protect.

Dearborn Chemical Company

310 S. Michigan Ave., Chicago

299 Broadway, New York

Reliance Gauge Column Co., Cleveland, Ohio.
Rogers Co., H. A., New York.
Sarco Company, Inc., New York.
"S-C" Regulator Mfg. Co., The, Fostoria, Ohio.
Squires Co., The C. E., Cleveland, Ohio.
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Williams Valve Co., D. T., Cincinnati, Ohio.
Wright-Austin Co., Detroit.
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STEAM TURBINES—POWER.
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Elliott Co., Jeannette, Pa.
General Electric Co., Schenectady, N. Y.
Moore Steam Turbine Co., Wellsville, N. Y.
Standard Turbine Corp., Scio, N. Y.
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Flynn & Emrich Co., Baltimore.
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Hofft Co., The M. A., Indianapolis, Ind.
Riley Stoker Corp., The, Worcester, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.
United Stokers Co., LaPorte, Ind.

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Flynn & Emrich Co., Baltimore, Md.
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Dean Bros. Co., Indianapolis.
Elliott Company, Jeannette, Pa.
Ross Heater & Mfg. Co., Buffalo.
Sarco Co., Inc., New York.
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Badenhausen Corporation, Philadelphia, Pa.
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Littleford Bros., Cincinnati, O.
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Armstrong Machine Wks., Three Rivers, Mich.

TRAPS, RADIATOR.
Armstrong Machine Wks., Three Rivers, Mich.
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Illinois Eng'r'g. Co., Chicago.

TRAPS, VACUUM.
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Bundy Steam Trap Co., Nashua.

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National Tube Co., Pittsburgh.
Scully Steel & Iron Co., Chicago.

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Worthington Pump & Machinery Corp., New York.

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Ric-Wil Co., The, Cleveland.

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Dart Mfg. Co., E. M., Providence, R. I.
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Kelly & Jones Co., The, Greensburg, Pa.

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Kennedy Valve Mfg. Co., Elmira.
Metallo Gasket Co., New Brunswick, N. J.
New York Belting & P'k'g Co., New York.

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VALVES, ALTITUDE.
Golden-Anderson Valve Specialty Co., Pittsburgh.

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Powell Co., Wm., Cincinnati, O.
Scully Steel & Iron Co., Chicago.
Yarnall-Waring Co., Philadelphia, Pa.

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Kennedy Valve Mfg. Co., Elmira.
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Schutte & Koerting Co., Phila.
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VALVES, FLOAT.
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Fisher Governor Co., The, Marshalltown, Iowa.
Illinois Engineering Co., Chicago.
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Yarnall-Waring Co., Philadelphia, Pa.

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Lunkenheimer Co., Cincinnati.
Powell Co., Wm., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, Ohio.

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Kelly & Jones Co., The, Greensburg, Pa.
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Lunkenheimer Co., Cincinnati.
Powell Co., Wm., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, Ohio.

VALVES HYDRAULIC.
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Kennedy Valve Mfg. Co., Elmira.
Williams Valve Co., D. T., Cincinnati, Ohio.
Yarnall-Waring Co., Philadelphia, Pa.

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Edward Valve & Mfg. Co., The, East Chicago, Ind.
Elliott Co., Jeannette, Pa.
Golden-Anderson Valve Specialty Co., Pittsburgh.
Illinois Engineering Co., Chicago.
Lunkenheimer Co., Cincinnati.
Ruggles - Klingemann Mfg. Co., Salem, Mass.
Schutte & Koerting Co., Phila.

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Ashton Valve Co., Boston, Mass.
Lonergan Co., J. E., Phila., Pa.
Lunkenheimer Co., Cincinnati.

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d'Este Co., Julian, Boston.
Elliott Company, Jeannette, Pa.
Fisher Governor Co., The, Marshalltown, Iowa.
Golden-Anderson Valve Specialty Co., Pittsburgh.
Illinois Engineering Co., Chicago.
Mason Regulator Co., Boston.
National Regulator Co., Chicago.
Ruggles - Klingemann Mfg. Co., Salem, Mass.
Powers Regulator Co., Chicago.
Squires Co., C. E., Cleveland, O.

VALVES, REGRINDING.
Homestead Valve Mfg. Co., Homestead, Pa.
Mason Regulator Co., Boston.
Penberthy Injector Co., Detroit.
Williams Valve Co., D. T., Cincinnati, Ohio.

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Davis Regulator Co., G. M., Chicago.
Golden-Anderson Valve Specialty Co., Pittsburgh.
Powers Regulator Co., The, Chicago, Ill.
"S-C" Regulator Mfg. Co., The, Fostoria, Ohio.

VALVES, RELIEF.
Davis Regulator Co., G. M., Chicago, Ill.
Edward Valve & Mfg. Co., The, East Chicago, Ind.
Fisher Governor Co., The, Marshalltown, Iowa.
Golden-Anderson Valve Specialty Co., Pittsburgh.
Illinois Engineering Co., Chicago.
Lonergan Co., J. E., Philadelphia, Pa.
Mason Regulator Co., Boston.
"S-C" Regulator Mfg. Co., The, Fostoria, Ohio.

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Garlock Packing Co., Palmyra, N. Y.
New York Belting & P'k'g Co., New York.
Quaker City Rubber Co., Phila.

VALVES, SIGHT FEED.
Nugent & Co., Wm. W., Chicago.

VALVES, STOP.
Edward Valve & Mfg. Co., The, East Chicago, Ind.
Golden-Anderson Valve Specialty Co., Pittsburgh.
Homestead Valve Mfg. Co., Homestead, Pa.
Schutte & Koerting Co., Phila.

VALVES, STOP AND CHECK.
Golden-Anderson Valve Specialty Co., Pittsburgh.

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Coppus Engineering Corp., Worcester, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.
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Irving Iron Works Co., Long Island City, N. Y.

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Reliance Gauge Column Co., Cleveland, Ohio.
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Permutit Co., The, New York.
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WATER SOFTENING SYSTEMS.
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Lonergan Co., J. E., Philadelphia, Pa.
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WIRE OF EVERY DESCRIPTION.
American Steel & Wire Co., Chicago and New York.

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Why?

Why don't you make sure that you're getting all you are entitled to?

Why don't you find out whether or not your boiler feed pumps are wasting your money through inefficiency, frequent need for repairs, and necessity for constant supervision?

Users of Buffalo Boiler Feed Pumps report savings in power, high efficiency and infrequent repairs—and they RE-ORDER.

Why not let us quote on your next pump?

Buffalo Steam Pump Co.

188 Mortimer St. Buffalo, N. Y.

"Buffalo" **Boiler Feed pumps**

POOR DRAFT?

Don't worry

Just read our Bulletin No. 145. It solves the draft question.

The Coppus Forced Draft Blower, Type C, at least doubles the capacity of your chimney, thereby giving the following advantages:

Increased Boiler Rating with any Grade of low priced Fuel—Perfect Combustion—No Smoke.

Automatic Operation.

Turbine Driven

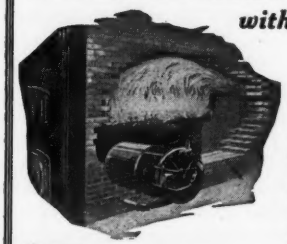
REGISTERED COPPUS U.S. PAT. OFFICE **Engineering Corporation**

340 Park Ave., Worcester, Mass.

Get most heat from your coal

with the **Wing** Turbine Blower

The Original - The Standard



A prominent manufacturer applied the Wing to his boiler in which Mine Run coal was burned. Result: 13 per cent less fuel required per horsepower! The Wing paid for itself within 3 months! Mighty few good plants but could be made better by installing Wing Blowers. How this is done at little trouble or expense is covered by the Wing Blower Book, sent you for the asking.

Ask for Bulletin 77

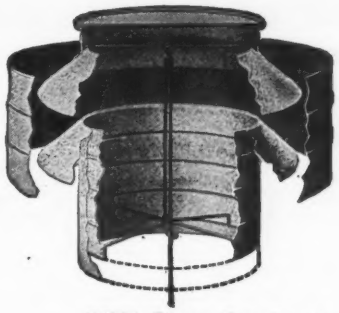
BOILERABILITY

L. J. Wing Mfg. Co.

659-669 Hudson Street, New York

Offices in principal cities

BURT *offers*

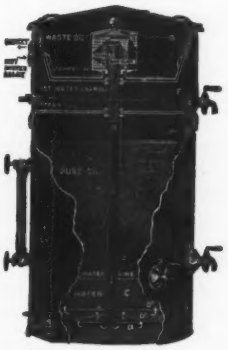


BURT Glass Top Ventilator

Complete Service

to solve filtering, exhaust and ventilating problems

Starting in 1891, Burt Specialists have solved the widest variety of difficult problems with a degree of satisfaction that has caused hundreds of repeat orders.



American Oil Filter

VENTILATORS

Recent reductions in price on nearly all types of Burt Ventilators enables you to secure ventilators of the very highest grade and in types, sizes and metals for every purpose at costs that compare favorably with ventilators of much lower quality and without Burt Exclusive Features of design.

OIL FILTERS

There's a Burt Filter for every grade of oil, every kind of plant, every possible set of operating conditions—single filters, unit filters and double unit filters—they save 50% to 90% of oil bills. Standard Oil Co. has placed 475 orders, U. S. Steel Corp., 449. Let us send a filter on 30-day free Trial.

Standard Exhaust Head

EXHAUST HEADS

Two types in any size and gauge of metal to meet your plant conditions. Take the oil and water out of the exhaust and save buildings and prevent damage suits. U. S. Steel Corp. has placed 176 orders.

Write us fully on any of your problems. We are ready to serve you promptly.

BURT Products

Glass Top Sliding Sleeve Ventilator
Metal Top Cone Damper Ventilator
Weave Shed Double Damper Ventilator
Metal Top Sliding Sleeve Ventilator
Rectangular Ventilator
Fan Ventilator
Burt Exhaust Head
Standard Exhaust Head
Cross Oil Filter
American Oil Filter
"Gary Type" Oil Filter
Unit Type Oil Filter
Oil Reservoirs
Oil Pumps
All Types and Sizes

Catalogue on Request

The BURT Mfg. Co.

44 E. South St.

Akron, Ohio, U. S. A.

Pioneer Oil Filter Manufacturers.
Makers of Ventilators and Exhaust Heads.

The Canadian Fairbanks-Morse Co., Ltd., Montreal, Sole Representatives for Burt Oil Filters and Burt Exhaust Heads for Canada.

George W. Reed & Co., Ltd., Montreal, Sole Manufacturers of Burt Ventilators for Canada.

SIGNBOARD SECTION

Quick Action Opportunities

CLASSIFIED RATES

Advertisements in the Signboard Section which come under the classification "Position Wanted," "Help Wanted," "Salesmen and Agencies," "Business Opportunities," "Patent and Patent Attorneys" and "Technical Books" will be set in type as shown below and published at the rate of

50 cents a line

each insertion, 6 words to a line; minimum sold, 4 lines.

For display of any advertisement under the above classified headings see sizes and rates in column at right.

DISPLAY RATES

Advertisements in Signboard Section which come under the classification "Equipment for Sale," "Equipment Wanted," "Educational and Instruction" and "Miscellaneous" are set in display space of the following sizes and at these rates:

1 in.	$ 5.50	4 in.	$20.80
2 in.	10.80	1 col. (8½ in.)	43.35
3 in.	15.90	2 col. (17 in.)	85.00

Not less than one inch to be sold in these classifications.

For advertising rates under other headings in this section, see column at left.

POSITIONS WANTED

POSITION WANTED — Eleven years' training and experience in sales engineering, design and testing of power plant machinery have qualified me for executive work in this field. Large acquaintance with engineers and manufacturers and fully understand sales and manufacturing methods to give results. Prefer position with financial and active interest in the company. In writing give full details of proposition. Box 838, POWER PLANT ENGINEERING, 537 S. Dearborn St., Chicago, Ill.

Position wanted as apprentice in power plant in Iowa or western territory. Age 35. Have 10 years' experience boiler and engine operation. First class license for Detroit. Desire work in modern plant. Willing to start at bottom and work up. Geo. Adams, 2413 Orleans St., Detroit, Mich.

WANTED: Steady position with a reliable company as a steam engineer. I have had 20 years' experience with large and small central stations. Can design your plant to make it paying proposition to you. I am married, 33 years old. Ohio license. A. A. Hampshire, 427 Seneca St., Defiance, O.

HELP WANTED

Civil or Mechanical Engineer wanted with some experience in handling mechanics for construction maintenance and repairs in Chemical factory near Philadelphia. Married man not over 35 years old preferred. Must state in application, which will be treated confidentially, training, experience, references and salary required. Address Box 845, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

SALESMEN AND AGENCIES

SERVICES AND CAPITAL TO INVEST —Executive, 34 years; experience in the power plant business; has built up and handled a sales and engineering organization of considerable size; has introduced new methods and equipment in several industries — desires connection with growing concern or with parties controlling new device of ESTABLISHED merits. Address Box 846, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill.

Good live salesman, mechanically inclined to sell the best boiler feed water treatment on market. Now being used in thousands of boiler plants. Liberal commission basis. Paige & Jones Chem. Co., Hammond, Ind.

Salesmen and Local Agents calling upon Manufacturing and Power Plants to handle our Boiler Compound, Boiler Setting Cement, Belt Dressing and Stack Paint. Guaranteed Products. Full time or side line. Address Box No. 842, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill.

Sales Engineers established in Boston, Mass., for ten years, wish to represent in New England a manufacturer of power plant or factory equipment. Address Box 844, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

SALESMEN AND AGENCIES

ENGINEERS—Earn big money in your SPARE TIME by selling our steam Trap —wonderful proposition—large commissions to producers. Write for full details to G. P. O. Box 139, New York City.

PATENTS AND PATENT ATTORNEYS

A. P. CONNOR, Consulting Electrical and Mechanical Engineer. Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf

PATENTS — Booklet free. Highest references. Best results. Send drawing or model for search and report. WATSON E. COLEMAN, Registered Patent Lawyer, 644 G Street, Washington, D. C.

MISCELLANEOUS

If readers having finished with their Sept. 1st copies of Power Plant Engineering will send them to us, we will pay 15c per copy for same. Allen-Sherman-Hoff Co., 261 S. 15th St., Philadelphia, Pa.

SERVICE TO SUBSCRIBERS—If you want information regarding any kind of power plant apparatus or supplies, write to Subscribers' Service, POWER PLANT ENGINEERING, 537 S. Dearborn St., Chicago, Ill., and tell us what you would like. The Service will be glad to give you such information and put you in touch with manufacturers who can supply your needs.

SIGNBOARD SECTION
Quick Action Opportunities

EQUIPMENT WANTED

Wanted to Purchase
250 Kilowatt high speed engine

Generator
used set in good condition. 60 cycles, 3-phase. 240 volts, steam pressure about 115 lbs. Also 2 duplicate 150 Kilowatt sets.

UNION FIBRE CO., Inc.
Winona, Minn.

Get the Cash into Your Coffers

DON'T let real money slip by. Get it into your coffers where it belongs. Right now there are numerous plants throughout the country ready to loosen their purse strings to give the money to you. These plants are long on cash but short on equipment.

But in your plant it's different. The machinery that has outgrown usefulness for you will give good service elsewhere. And you will get a good cash consideration for it.

Can you afford not to sell? The market for used equipment is a brisk one and it's your opportunity to sell at a price that's right. A message in the Signboard Section will assist you in reaching over 23,000 prospects.

EQUIPMENT FOR SALE

For Sale
Motors

	Make	H.P.	R.P.M.	Volts	Amp.	Cycle	Phase
1	Allis	150	695	2200	209	60	3
1	G. E.	125	700	2200	176	60	3
1	G. E.	50	1150	220	126	60	3
1	Westinghouse	50	1170	220	117	60	3

3 Maloney Transformers

Make	K.V.A. Capacity	Prim Volts	Sec. Volts	% Taps	Cycle	Type	Phase
Maloney Elec. Co.	75	2200	220	5 & 10	60	H.E.	1

This equipment has been used but very little.

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WINONA, MINN.

FOR SALE
One cross-compound steam-driven York ammonia compressor 250-ton refrigerating capacity, steam valve gear combination of Poppett and Corliss, together with one Wheeler steam condenser and vacuum pump complete, of sufficient size for above machine.

All now in service, in first class condition and as good as new. Detailed specifications on request.

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200	"	C.W.	Erie Ball
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Save over Half
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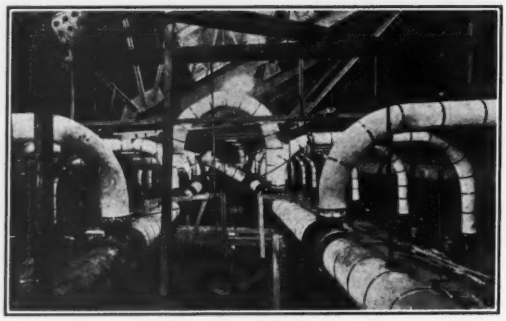
PITTSBURGH PIPING FOR POWER PLANTS



THERE is a way to forestall any decrease in your steam efficiency. That way is to pay as much attention to the selection of your piping as is paid to the selection of any other part of your Power Plant equipment.

Pittsburgh Piping is the choice of engineers who from experience know Pittsburgh Piping for its continuous, efficient and economical conveying of steam, either saturated or superheated.

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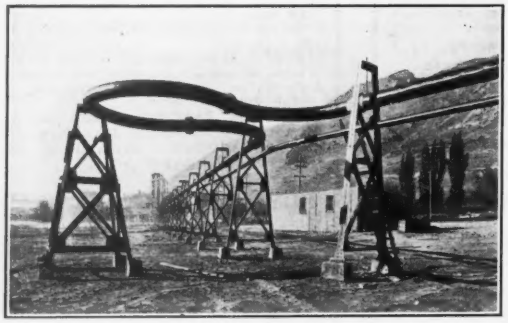

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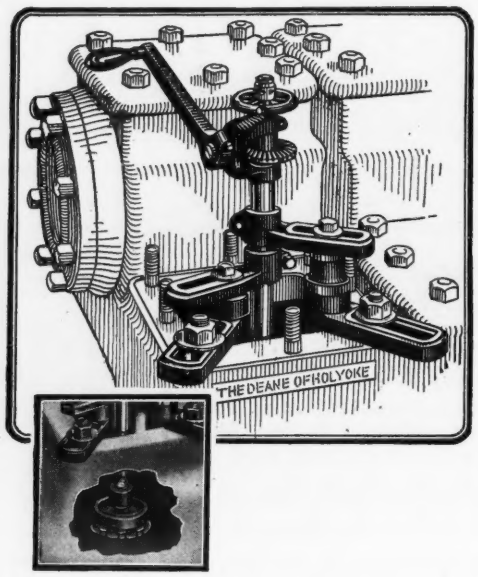

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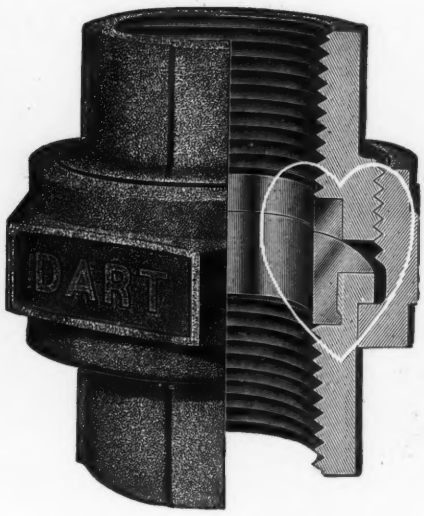

The Bronze-to-Bronze Seat at the Heart of the DART makes it *First in the hearts of Its Users–*

our Catalogue "T" *tells* why, and the FREE Sample Union *proves* it! Write for both.

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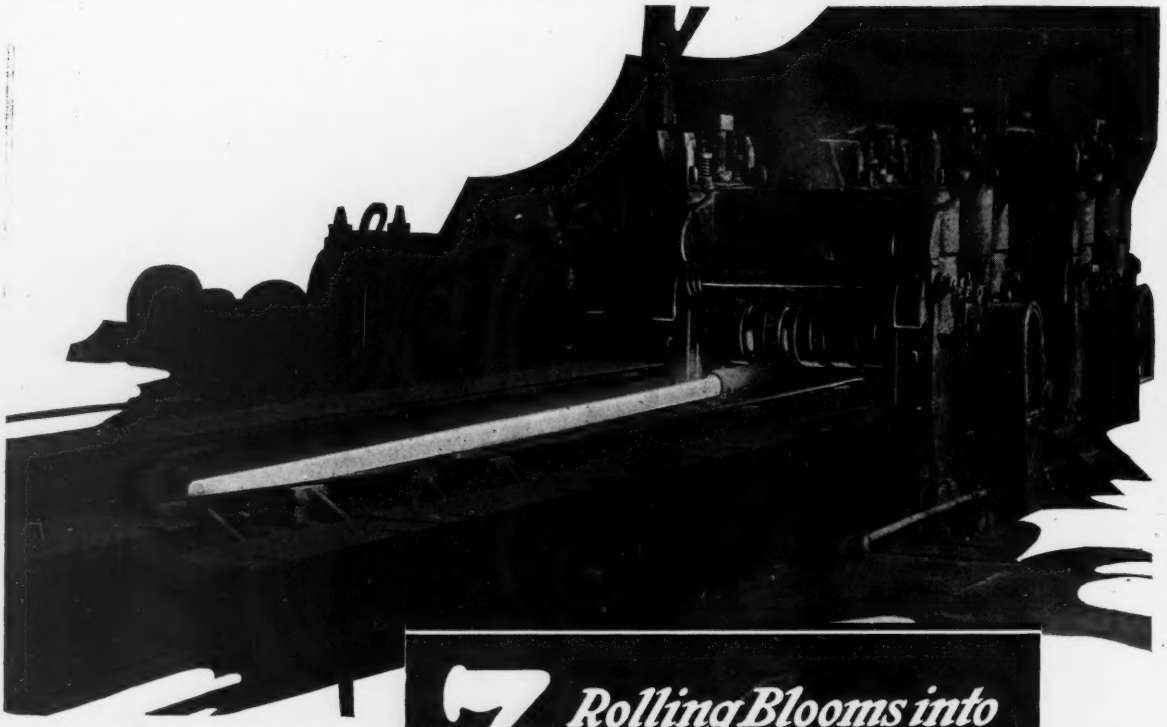

3 Rolling Blooms into Round Billets for Seamless Boiler Tubes

AFTER being heated to suitable temperature, the uniform blooms of Open-hearth steel are passed through a series of rolls which transform them from a square bloom into long, solid round billets. The additional working of the metal by these rolls is under expert supervision and is another step in the careful handling of the steel to insure the highest possible grade of material in the completed tube.

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NATIONAL SEAMLESS BOILER TUBES

(SHELBY)

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How Williams' engineers *have made $28.00 do the work of $150.00*

IN designing the new Williams Rapiduction Die Head the inventive genius and mechanical skill of Williams' engineers were focused on designing a head that would above all considerations deliver *quality threads at a high speed rate of production and at a low production cost.*

How well they succeeded is evidenced by the heretofore unequaled records the new Rapiduction machine has definitely established with a capacity for producing *four times the volume of threads in the same length of time* as its old rivals.

But in designing a machine with the high-speed ability of the new Rapiduction, Williams' engineers also succeeded in designing and building a die head that gives a complete range of 1" to 5" with one change of chaser bits.

For example in the new Williams Rapiduction Pipe Threader a complete set of dies covering the range from 2½" to 6" for Rapiduction Die Head cost $14.00, compared with $120.00 for old type die. For range from 1½" to 2", $14.00 compared with $30.00. Moreover, in case single chaser bit becomes worn out, only this bit needs to be replaced. And this is done in 10 seconds at the low cost of $2.00—compared with the necessity of replacing complete set of dies in old type machine at a cost of $30.00.

Let us tell you how you can get more production, reduce your labor costs and save definite dollars on die costs with a new Williams Rapiduction Pipe Threader.

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The Williams line includes pipe threading machines covering the entire range of pipe threading—from ⅛" to 24".

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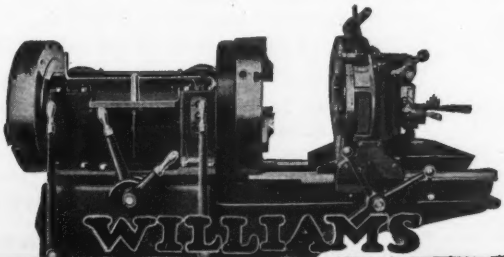
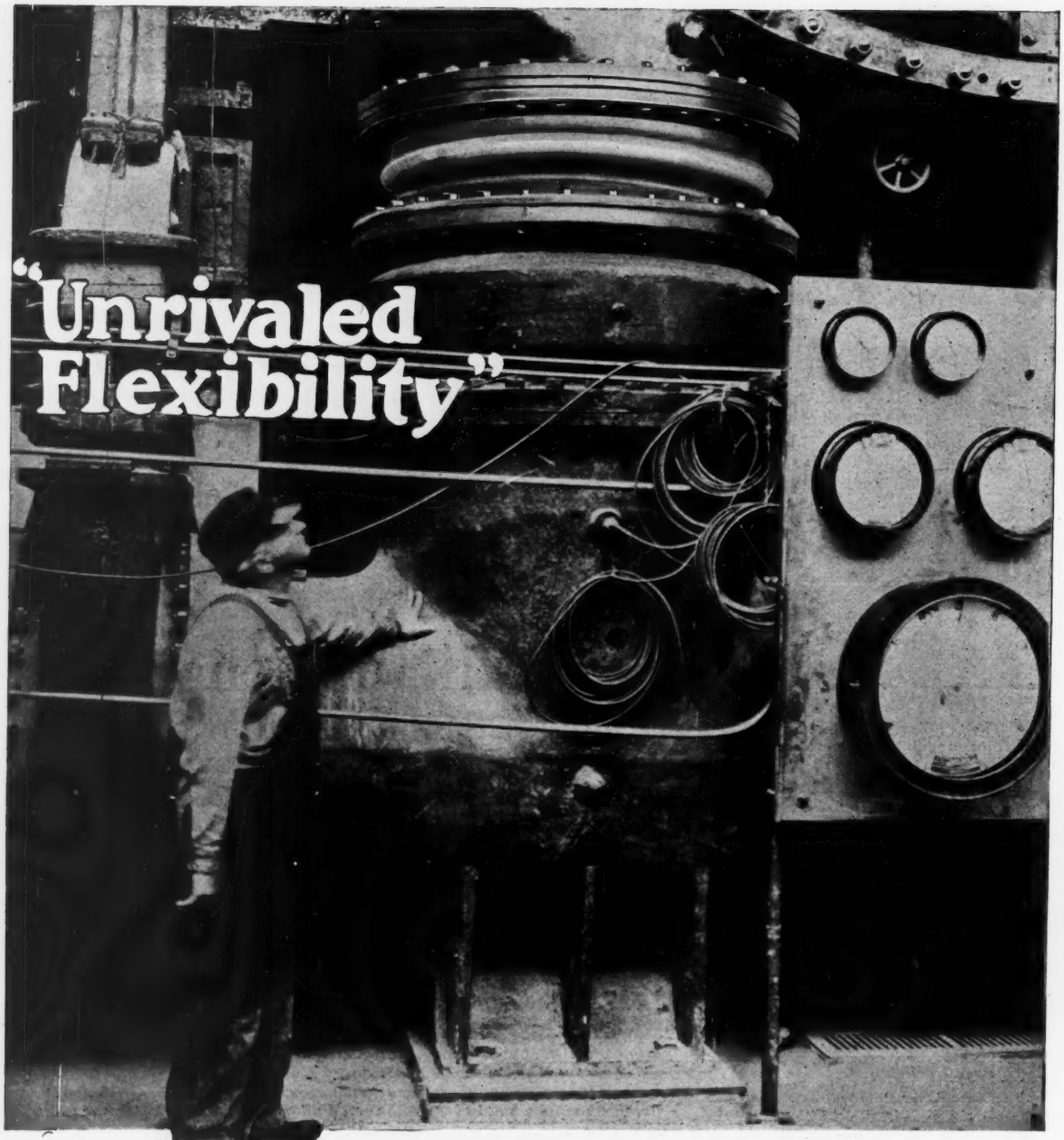


WILLIAMS
RAPIDUCTION
POWER PIPE MACHINE



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The enduring flexibility of the heavily reinforced rubber of "U.S." Joints permits a free movement under expansion and contraction, without developing undue stresses in the turbine casing or condenser shell. They have a long life because they are not affected by frequent full expansion and contraction or vibration. They will not crack, harden or lose their pliability. Face to face dimensions only 6-in. to 16-in. Applicable to all vacuum and low pressure service.

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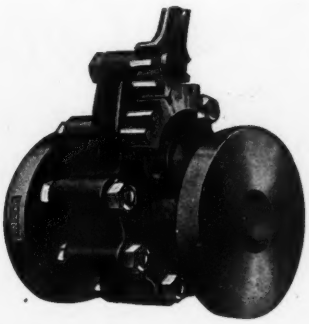

Everlasting Valves

on severest boiler blow-off service are guaranteed drop-tight for two years. Over 430,000 of them have more than made good on that guarantee.

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Yarway Tandem Blow-Off Valve — Yarway Seatless Blow-Off Valve — Yarway Double-Tightening Valve — Yarway Involute Spray Nozzle — Yarway Adjustable Spray Head — Yarway-Lea V-Notch Meter — Yarway Hydraulic Valve — Yarway Pipe Clamps — Yarway Unloader — Yarway Steam Trap.

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"Entire Expense for 2 Years is Less than $1.00"

So writes the Chief Engineer of a great city water works about 2 pumps equipped with Birch Pump Valves. Write for circular giving the complete letter and other facts.

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Pop Safety Valve

Pop Safety Valve Model "WRT," shown above as well as Model "WT" for water tube boilers, assure positive opening and gradual closing with minimum blowdown and exceed Code requirements by a wide margin.

Model "WRT" for Fire Tube and Return Tubular Boilers meets all requirements of revised A. S. M. E. Code — and more.

Builders and operators of boilers demanded a new pop safety valve to insure greater protection of equipment and men.

As leaders in building boiler, steam and gas engine specialties for fifty-four years, we now offer the new Pop Safety Valve Model "WRT." It conforms to the changes recently made in the A.S.M.E. Boiler Code, but, unlike other valves, its capacity is greater than Code and based on sustained, not instant lift.

But, as with all Lonergan Specialties, it is built far better than required to assure plant and men the greater safety and service.

If you mail the coupon, we will send you full details and gladly advise on your problem.

A full line of Safety Steam Devices

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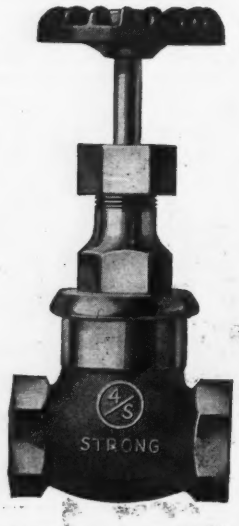
Yes, *this* is the valve with the Anum-Metl Disc and Seat!

—the same metal that has saved so much money, time and trouble in the valves and seats of Strong Steam Traps—now made available for valve users in the disc and seat of this Strong Heavy Duty Valve, built right from top to bottom. It's a real valve guaranteed for a year of leak-tight service—but we can't describe it here—so write now for circular No. N-1.



STRONG Heavy Duty Valve

Leak-Tight for at Least One Year

The Strong, Carlisle & Hammond Co.
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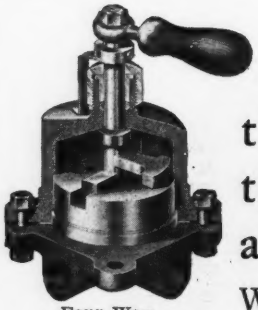

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Automatic Eliminators
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NICHOLSON *Steam Specialties*

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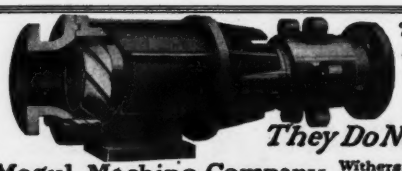

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SHEET AND PLATE STEEL CONSTRUCTION
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SEND today for Hanger Catalog No. 3. It contains complete data and illustrations of over 100 hangers.

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Fittings Hangers Valves Welds Etc.

Cuts valve costs in half

COSTS count in these days and the cost of a valve is by no means its first cost. Figured on the cost per year of leak-tight service, Reverso Valves win their way with the closest buyers.

Both seat and disc being easily reversible, the life of Reverso is doubled by this feature alone with no extra expense. Then each side of both the seat and disc are good for many regrindings.

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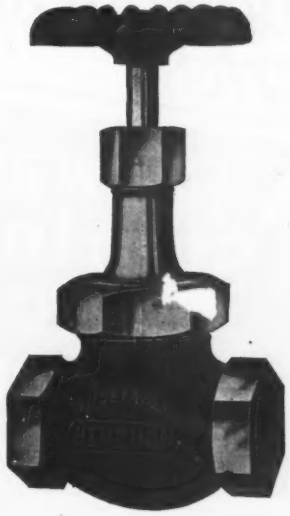
IROVERSO: Iron Body for 150 lbs. Pressure. Total Temperature, 450° F.



REVERSO

The Valve with the Reversible Disc & Seat

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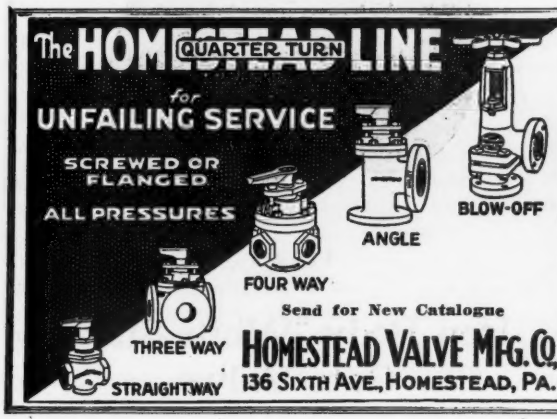
The HOMESTEAD QUARTER TURN LINE for UNFAILING SERVICE

SCREWED OR FLANGED ALL PRESSURES



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The EDWARD *Line*

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- Globe and Angle Stop Valves
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- Drum Head Stop and Check Valves
- Blow-Off Valves
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DESIGNED and constructed with the stamina to withstand highest pressures and temperatures.

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Representatives in all Principal Cities

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THE MORSE "ROCKER JOINT"

A Power Saver for Power Users

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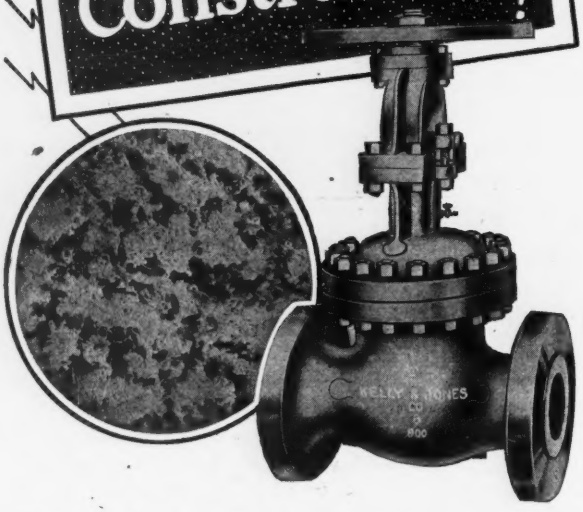
A Material that Marks

A Forward Step In Valve Construction



The material in any valve determines to a large extent its life and service.

The fine grain metal shown in the photo-micrograph comes from the electric furnace and possesses great strength and uniformity. Electric steel means longer life, fewer repairs and replacements, less shut-down time, and lower power costs.

For high temperature and pressures, every experienced engineer will specify and insist on electric steel valves. To be sure, look for the K & J monogram and the words ELECTRIC STEEL.

Made in all sizes for 250, 400, 600 and 900-pound steam working pressures and temperatures to 750° F.

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WORKS · GREENSBURG, PENNA.

Electric Steel Valves

If you want long service

Powell Valves

will not disappoint

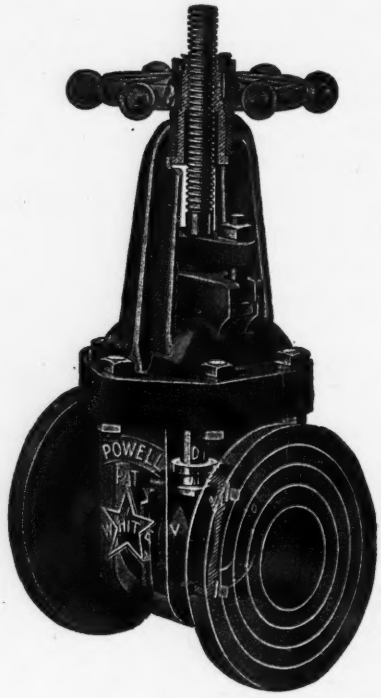

Fig. 414

Iron Body "White Star" Gate Valve

with rising stem. For working pressures up to 150 and 250 pounds.

Sizes 2 to 12 inches.

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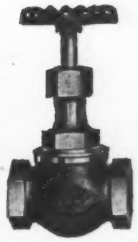

Fig. 106
Screwed, Jenkins Standard Bronze Globe Valve.

Jenkins Standard Bronze Globe Valves on injector lines. Boiler room, Sweet-Orr Overall Co. Some of the valves in this illustration have been in service over fifteen years.

Jenkins Standard Iron Body Gate Valves on pump, Engine room, Sweet-Orr Overall Co.

"We standardize on Jenkins"

—*Sweet-Orr Overall Plant*

The chances are you've worn a pair of Sweet-Orrs yourself once, if not often. It's a sure bet that some of your men are wearing these overalls today.

In the Sweet-Orr plant at Newburgh, N. Y., there's no place for equipment that doesn't "deliver the goods." And here, in maintaining efficient plant operation, Jenkins Valves play an important part.

Mr. Jos. Bell, Engineer, has a long-standing respect for valves bearing the Jenkins "Diamond" mark.

In service over 15 years

"We have in service today," says Mr. Bell, "Jenkins Valves that were here when I came fifteen years ago. And they weren't new then."

"We standardize on Jenkins; they need so very little attention. All it usually amounts to is renewing a disc now and then, and that takes only a few minutes."

It will pay for your plant, too, to standardize on Jenkins. There's a genuine Jenkins Valve for practically every requirement.

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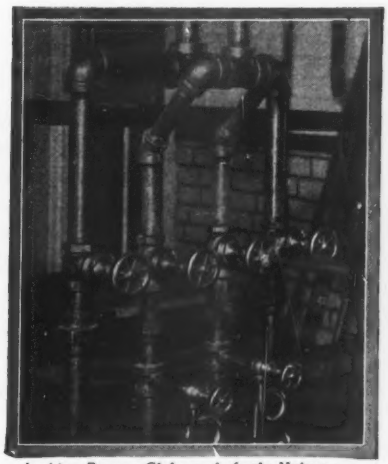

Jenkins Bronze Globe and Angle Valves on lines to pump system, Engine room, Sweet-Orr Overall Co.

Always marked with the "Diamond"

Jenkins Valves

SINCE 1864

KENNEDY

Fig. 91

Heavy Globe and Angle Valves

These valves are very strong and substantial, being made heavy in all their parts and of the best quality metal. They have an unusually large passageway for steam or fluids.

The stems are of special bronze of 50,000-lb. tensile strength. The discs are made of a special composition, the compressibility of which causes it to conform to uneven surfaces and make a perfectly tight joint with the seat. The valves are furnished with a gland and can be repacked under pressure.

Built for 150-lb. working steam pressure and 175-lb. working water pressure, and in sizes from ¼-inch to 3-inch. One of the big Kennedy line of 4600 different types and sizes described in Catalog 45 which will be sent on request.

Some other Kennedy Valves for power plants

Fig. 47
Low pressure Gate Valve
with clean-out pocket for removal of tar and other troublesome accumulations in gas oven, coke ovens and similar service. Built in a large variety of sizes and arrangements.

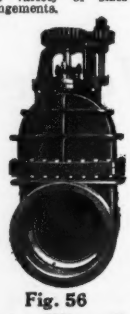

Fig. 56
Heavy Water Gate Valve
with spur gearing. Also arranged for electrical control, and with bypass.

Cylinder-operated Gate Valve
This arrangement can be applied to practically all Kennedy Valves of 2-inch size and larger.

THE KENNEDY VALVE MFG. CO., ELMIRA, N.Y.

BRANCH OFFICES AND WAREHOUSES:
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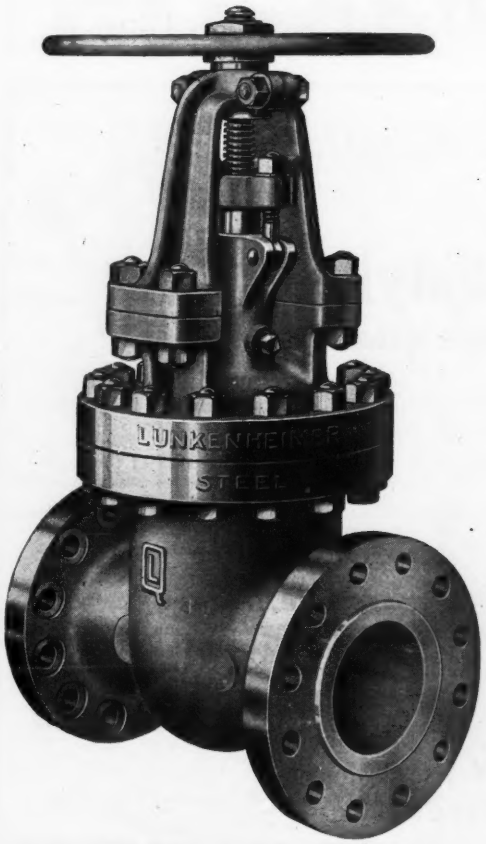
Some of the Central Stations which have selected

LUNKENHEIMER STEEL VALVES

PROCURABLE FOR

250, 400, 600, AND 900 LBS. W. S. P.



No better exemplification of the high quality of Lunkenheimer Steel Valves could be found, as the engineers who planned and built these magnificent plants are among the leaders in their profession.

Their equipment specifications were based on an accurate knowledge of the severe service demands at the prevailing high pressures and temperatures.

There is significance in the fact that they specified "Lunkenheimer" wherever high pressure valves were involved.

The wide experience gained through close contact with these and many other critical purchasers of high pressure equipment is at the service of every user of steel valves. A request for further information will receive prompt attention, and entails no obligation.

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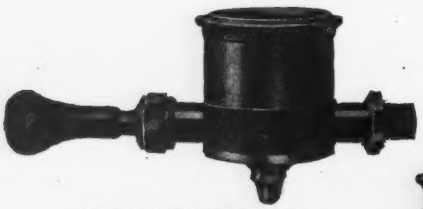

Fig. 116. Side outlet and bottom nut for brace.

Fig. 117. Bottom outlet. Both above types made also with glass body.

FELTHOUSEN HAND-OPERATED OIL PUMPS

the good old standby for oiling cylinders and hard-to-get-at journals

THESE Felthousen Hand Pumps are the standard equipment with many prominent engine builders. Users like the reliable feed, accurate threading, fine finish and all-around perfect performance.

Made with either side or bottom outlet and either plain brass or glass chamber, the latter to show the oil level. Capacities ¼ pt. to 1½ qt.

Sherwood lines include automatic as well as hand-operated lubricators, and a wide variety of oil and grease cups—all made for the Engineer who takes pride in his plant and wants strictly first-class equipment at reasonable price.

Sherwood equipment offers the best and most service per dollar invested—a statement that is backed by our liberal guarantee and 35-year reputation for square dealing.

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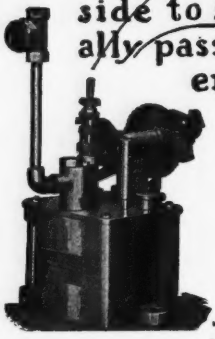
Hills-McCanna Blinker Type sight feed is located on the discharge side to show oil actually passing to delivery point



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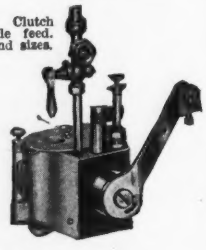
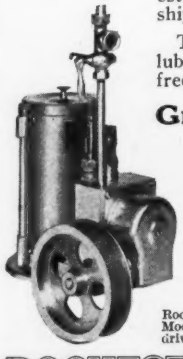


All styles —one quality

WHATEVER Rochester Lubricator you wish to try, clutch, ratchet or rotary drive model, 1 to 8 feed, 1 pint to 2-gallon capacity —you will always be sure of the highest quality in materials and workmanship.

They often outlast the machines they lubricate. Write for catalogue "T" and free trial offer.



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Rochester Automatic Lubricator Rotary Drive Model. Any size, rotary, clutch or ratchet drive, yours to try 30 days free.

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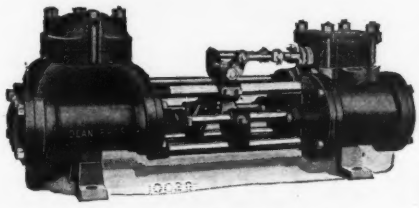
Dean Bros. Durable Duplex Steam Pump

represents the biggest improvement that has been made in duplex steam pumps within the last quarter of a century.



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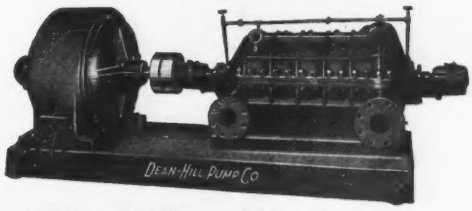

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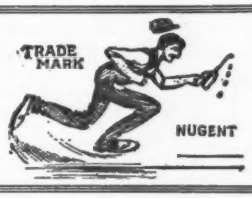

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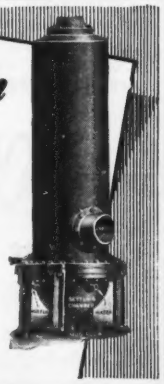

will heat the feed water from 40° F. to 212° F. and remove all impurities. They reduce fuel cost, increase the steaming capacities and life of the boilers and show the highest water-heating efficiency. Backed by 45 years' experience. Sold on 60 days' trial.

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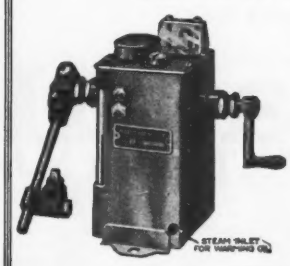

A test of 30 days will convince you that the "Manzel" Oil Pump is without a doubt the most dependable, most economical, most convenient oil pump you ever used.

You may try one on your engine, pump or compressor without obligation to keep it if it fails to satisfy.

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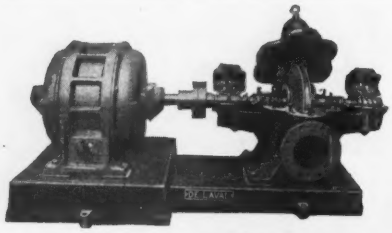
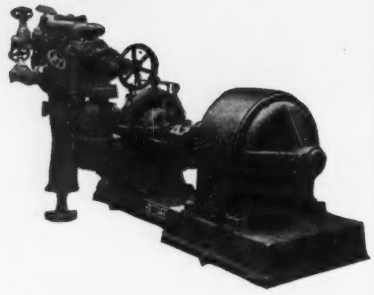


De Laval motor-driven single-stage pump for general water service.



De Laval motor-driven single-stage Underwriters' fire pump.

High Grade Pumps

For Modern Super-Power Stations

THE De Laval horizontally split casing pump is peculiarly suited to steam plant service because of:

1. Accessibility of internal parts;
2. Interchangeability of parts; and
3. High efficiency, low starting torque, and the power limiting characteristic.

THE Southern California Edison Co. has installed in the 70,000-kw. Long Beach Station two De Laval pumps for supplying water to air coolers at the rate of 1500 gal. per min. each against 65-ft. head, a similar pump to supply water to the transformer oil coolers, two pumps supplying 1500 gal. per min. against 125-ft. head for general water service, a fire pump of 2000 gal. per min. capacity against 260-ft. head, and seven transformer oil circulating pumps, each delivering 100 gal. per min. against 67-ft. head. All of these pumps are motor-driven.

Everything considered, including cost of power and cost for attendance, De Laval pumps are highly economical.

Ask for Catalog B-50

De Laval

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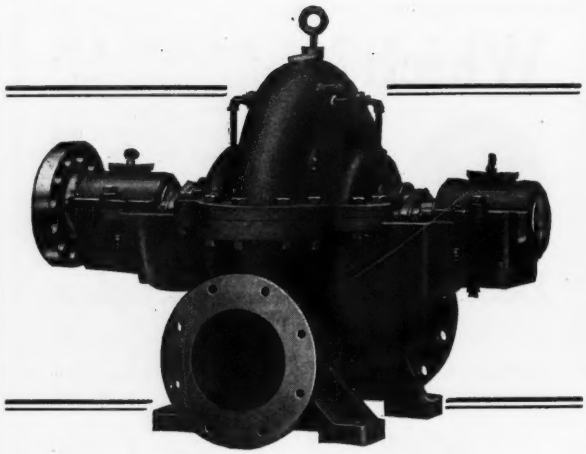
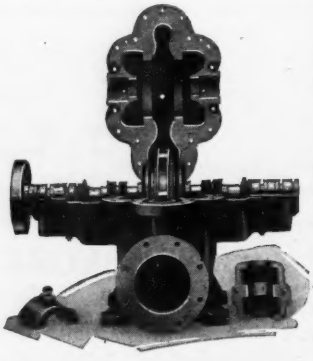
Manufacturers of Steam Turbines, Centrifugal Pumps, Centrifugal Blowers and Compressors, Double Helical Speed Reducing Gears, Worm Gears, Hydraulic Turbines, Flexible Couplings and Special Centrifugal Machinery



Your Idea Of a Good Pump

Everything about the Warren Centrifugal is just the way you'd have it yourself, if you had the chance to create your idea of a good pump.



Note the heavy casing, oversize, split shell, ring-oiling bearings, heavy steel shaft, split packing glands and deep water-sealed stuffing boxes, the high quality of materials and workmanship throughout. Compare it with pumps you are now using.

Realizing that *pumping* cost not pump cost determines whether a pump is really economical, Warren engineers set out to design and build a centrifugal pump that would reduce pumping cost to a minimum. The Warren Centrifugal is the successful result.

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Dependable Motor-driven Pumps

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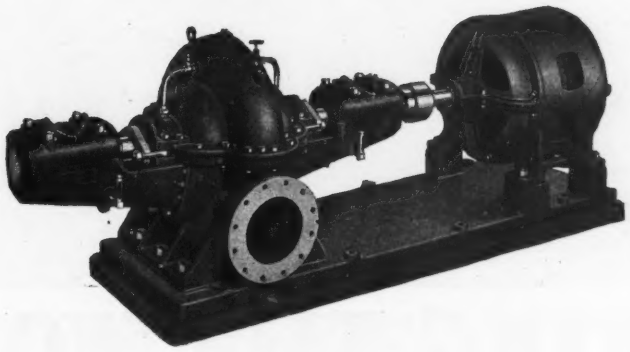
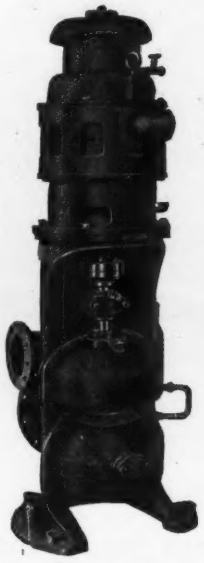


—a single - stage centrifugal pump for general liquid pumping duties

Bethlehem Horizontal Centrifugal Service Pump

A single-stage centrifugal pump—scientifically designed — embodying in its construction, strength and ruggedness to ensure the performance required for general liquid pumping duties. Standard units have double suction horizontally split casings, with suction and discharge connections on bottom half. Pumps are completely fitted to the latest and most approved specifications.

—a two-stage pump for condensate extraction



Condensate Extraction Pump

Bethlehem General Service Pump

A vertical spindle, centrifugal pump built one- or two-stage. This pump is applicable to a large variety of water pumping uses. Important features are: compactness of design, accessibility to all parts, and perfect motor and pump shaft alignment.

—built in single- and two-stage for pumping water

General Service Pump

Bethlehem Condensate Extraction Pump

A two-stage pump with vertical shaft, for condensate extraction. Suction is at the lowest possible point. Pump stable and efficient. First impeller designed for best possible vacuum, while second impeller deals with external head —its efficiency unimpaired by any consideration of vacuum.

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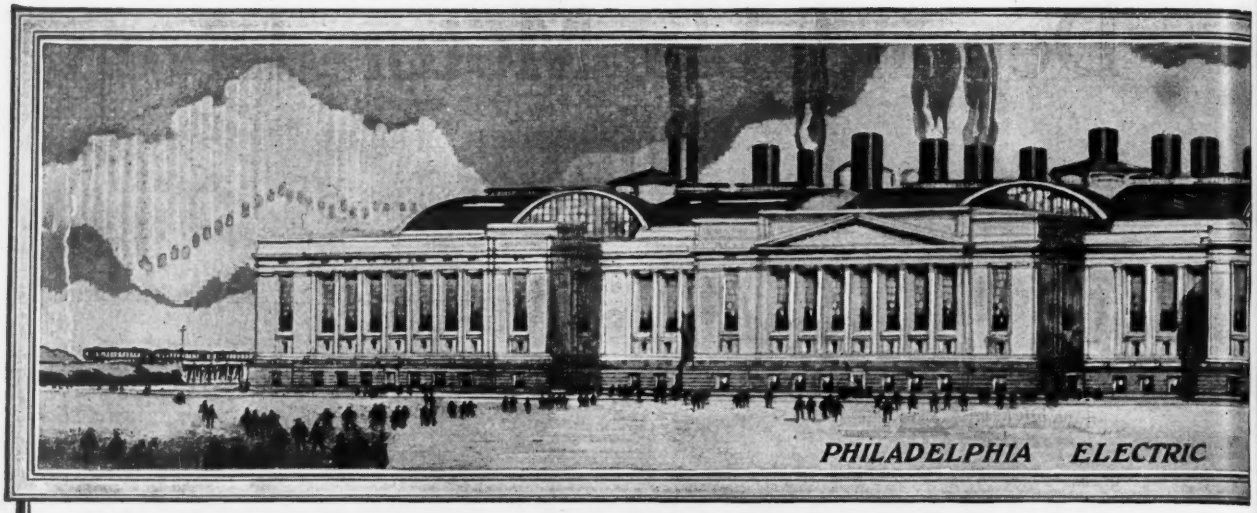

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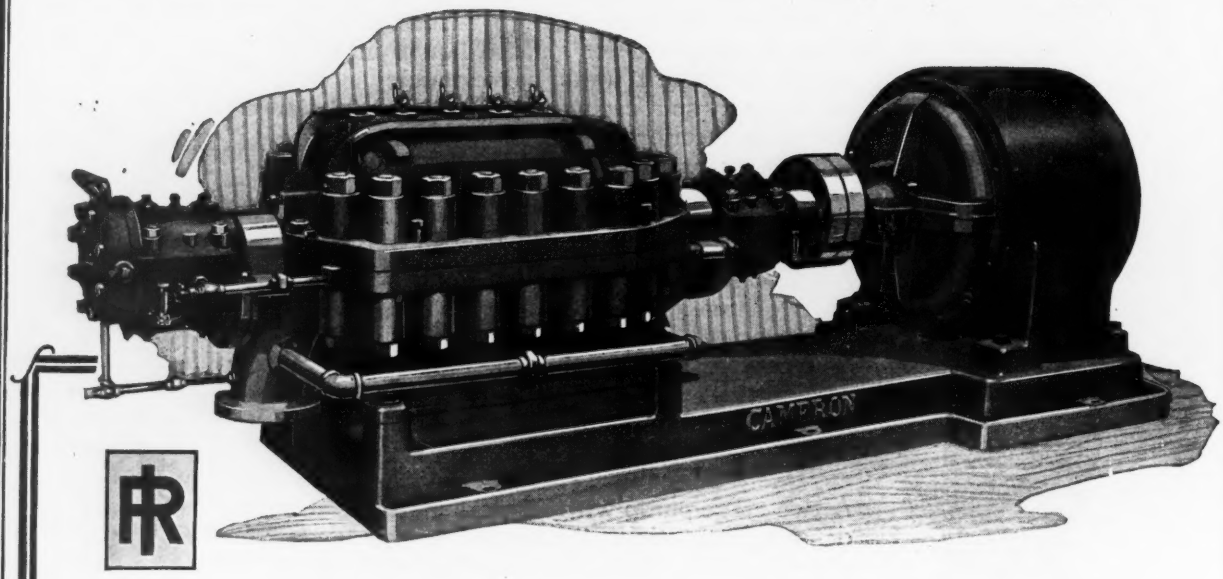
6 Cameron Six Stage High



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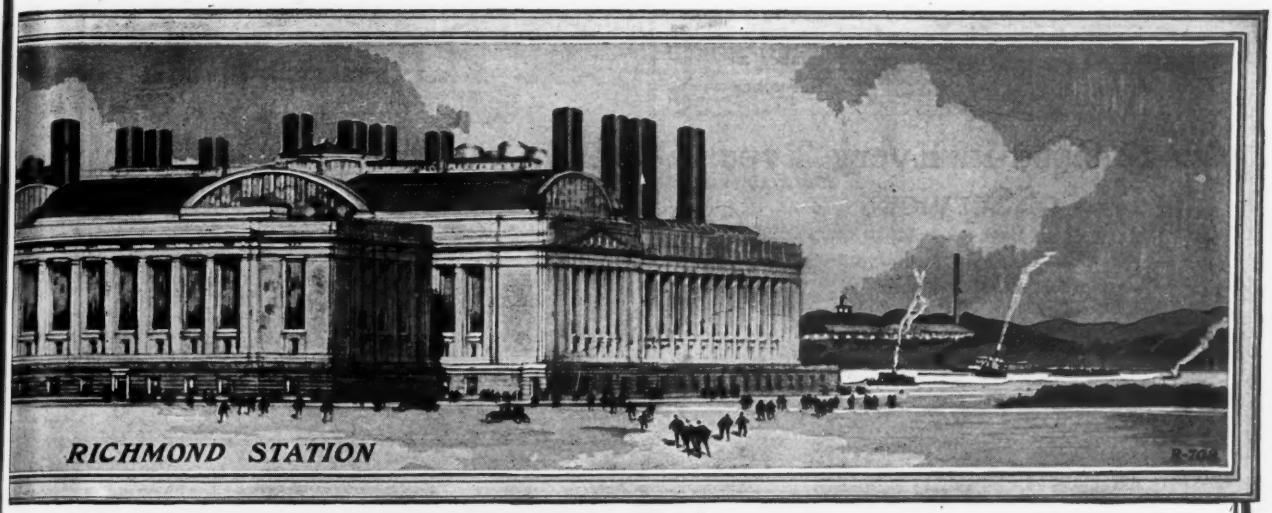

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Pressure Boiler Feed Pumps

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This mammoth generating station will have an ultimate capacity of 600,000 Kw. It will be constructed in three separate sections, each of 200,000 Kw. capacity. These sections will be connected electrically, but will be independent as far as buildings and equipment are concerned.

The normal steam conditions selected are 375 pounds gauge and 675 degrees F. At maximum loads the pressure will be 400 pounds and the temperature 720 degrees.

The selection of Cameron high-pressure boiler feed pumps is proof of their proven reliability under similar conditions in the numerous high-pressure stations throughout the country.

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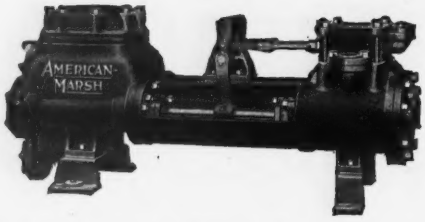
A. S. CAMERON STEAM PUMP WORKS

35 Years' Experience

AMERICAN-MARSH PUMPS

Makes a Difference

Make Good in Every Type of Service



Where durability and reliable performance are essential, American-Marsh pumps make good. In every capacity they deliver the highest type of service at low cost. Whether the load be heavy or light, rising gradually or suddenly, American-Marsh Pumps are dependable, day-in and day-out, year after year. In points of service and economy they are a good investment.

Guaranteed by a company of unquestionable reliability.

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DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS FOR LOCOMOTIVE MARINE AND STATIONARY BOILERS, FEED WATER HEATERS, PIPE COILS, ETC.

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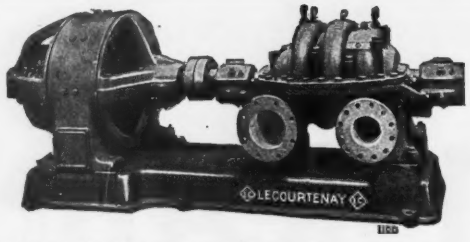

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LECOURTENAY COMPANY

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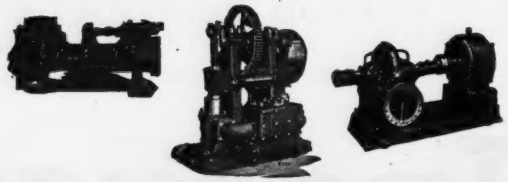

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Dayton, Ohio

"Platt" and "Smith-Vaile" Pumps
Steam and Power Pumping Machinery

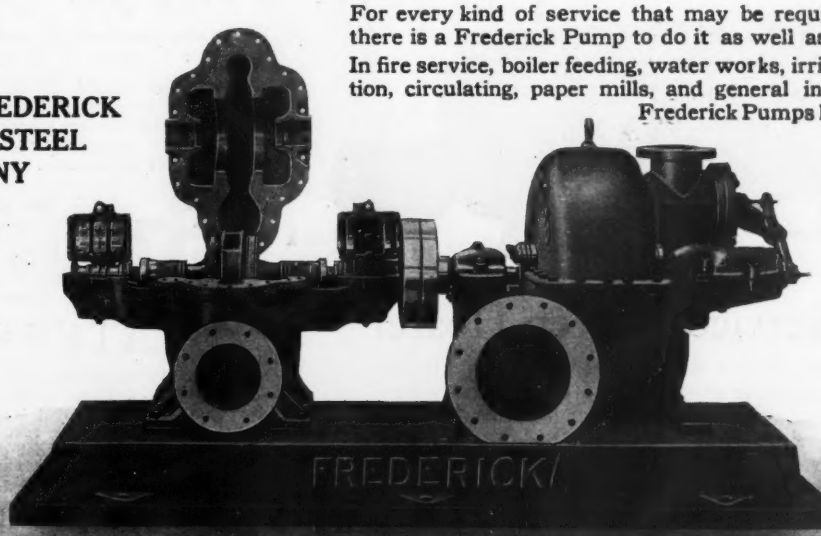
FREDERICK SINGLE STAGE AND MULTI-STAGE PUMPS

THE FREDERICK IRON & STEEL COMPANY
Frederick, Maryland

Whatever the work may be, there is a Frederick Pump entitled to consideration.

For every kind of service that may be required of a pump, there is a Frederick Pump to do it as well as it can be done.

In fire service, boiler feeding, water works, irrigation, reclamation, circulating, paper mills, and general industrial service Frederick Pumps have established their right to be considered the finest pumping equipment that is made.



MANISTEE

CENTRIFUGAL PUMPS

ROTARY JET CONDENSERS

Manistee Iron Works Co., Manistee, Mich

PUMPS of all types for practically all services. Single and multistage centrifugal pumps covering a wide range of requirements; steam pumps; power pumps in piston and plunger patterns for every type of drive. Ask for informative bulletins.

FAIRBANKS, MORSE & CO., Chicago
Manufacturers of Pumps, Oil Engines and Electrical Machinery
branches in the United States, each with a service station

FAIRBANKS-MORSE PUMPS
1137

BELT DRESSING FOR ALL BELTS

FREE ½ lb. Sample Bar

STEPHENSON BAR BELT DRESSING
PRESERVES BELTS - PREVENTS SLIPPING

Write your name, firm name, and address, on the margin of this page, tell us the kind of belt or rope drive to be treated, tear out, mail, and we will send FREE a half-pound sample bar of STEPHENSON.

We also have a 30-lb. 30-day trial offer. Want to learn about it?

STEPHENSON MFG. CO.
15 Spring, Albany, N.Y.

Trade Mark Registered

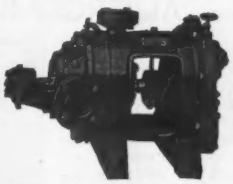
THE IDEAL BOILER FEEDER

Coppus Centrifugal Turbo Boiler Feed Pump

Single Unit Design. No flexible coupling or cast iron base plate. One single shaft for pump and turbine. Only two bearings and two low pressure stuffing boxes in the complete unit. Consequently, lowest upkeep, least attention and smallest floor space.

Bulletin 125.

Turbine or Electric Motor Driven

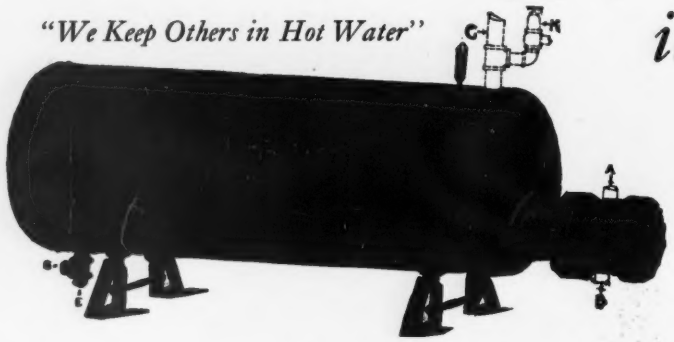


COPPUS ENGINEERING CORPORATION
340 Park Ave., Worcester, Mass.

Steam Turbine Driven
Turbo Blowers
Type C
Vano Blowers
Steam Turbines

Your Water Supply—*we'll make it* Hot *for you!*

"We Keep Others in Hot Water"



As hot as you like it and all you need of it—that's our business for 39 years.

Sims' Open and Closed Types of Feed Water Heaters save fuel bills, make feed water clean, and assure steadier boiler operation, more steaming capacity and the minimum of shutdowns.

Sims Service Water Heater

uses live or exhaust steam most effectively. It assures a dependable supply of hot, clean water wherever installed. Shell of best boiler plate in the lowest part of which are heating units of long, straight, seamless brass tubes. Condensation chamber keeps tubes free of water and at maximum heating capacity. Guaranteed to meet all requirements. Built for any storage capacity. Ask for special bulletin L-5.

We are also builders of Sims Open and Closed Feed Water Heaters and Sims Oil Filters.

SIMS HEATERS

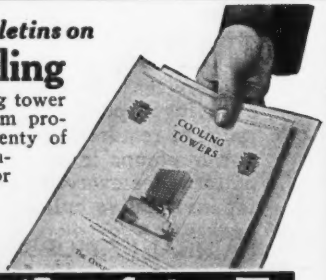
are serving leading power plants, industrial plants, hospitals, schools, office buildings, etc. Let our heat transference engineers bring to you the results of our experience in building highest grade water heaters for all purposes.

The Sims Company
2001 Holland St.
Erie, Pa., *A good place in which to live, to work and to play*

Send for these bulletins on
Water Cooling

A well designed cooling tower or spray nozzle system provides, at low cost, plenty of cool water for condenser use. Ask for Plant Data Sheet P.

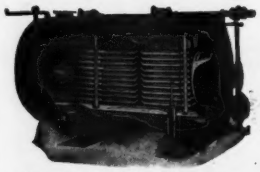
Air Washers
Air Filters



The Cooling Tower Co., Inc.
NEW YORK

Branches in Principal Cities

Profit by HOPPES



Hoppes Class "R" Exhaust Steam Feed-Water Heater. Built in all sizes, fully equipped with baffle plate oil separator, double-seated automatic regulating valve, skimmer overflow and hooded suction, cast iron or steel plate as preferred.

Advantages

exclusive to Hoppes Feed-Water Heaters and Purifiers are the trough-shaped pans or trays. Water flows over and under pans in thin films, assuring rapid heating and precipitation of lime, no chemicals required. Write for catalog No. 85 illustrating and describing many types of heaters, both vertical and horizontal, also V-Notch Meters, Steam and Oil Separators and a real cast iron Exhaust Head.

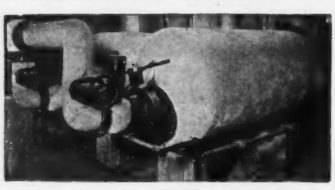
THE HOPPES MFG. CO., 70 Larch St., Springfield, Ohio

For Hot Water—

Whether your need is for feed water, a heating system or a manufacturing process or a domestic purpose—the cost will be less if you heat the water in

ALBERGER-BUFFALO Heaters

Scientifically designed for high heat transfer with Helically corrugated copper tubes. Divided floating tube head that eliminates expansion stress. Consult us on your requirements. Write.



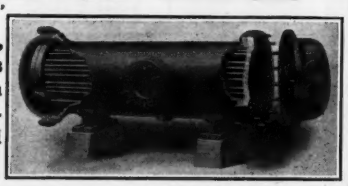
ALBERGER HEATER CO., HOWARD IRON WORKS 285 Chicago St., Buffalo, N. Y.

ROSS

BLEEDER AND INSTANTANEOUS HEATERS—HEAT EXCHANGERS

"Better than Specified"

Leader of the heaters, this Ross type has proved its worth wherever used, including central stations and utility companies.



Condensers: surface; low level jet; barometric; distilling. Coolers: for oil, water and all liquids. Expansion joints: crosshead-guided and internally-guided. De-aerators; Evaporators; Heat exchangers; Heaters: bleeder, high and low pressure; boiler feed, chemical, hot water system, oil, storage, sugar juice. Strainers: duplex, continuous service type.

ROSS HEATER & MFG. CO., Inc., Buffalo, N. Y.
Agents in all principal cities

It Can't Stop Up

because it's a

BADGER

Non-Clog

Nozzle

—because

there are no inner parts to become clogged with foreign matter, the water flows through an unobstructed path continuously.

—because

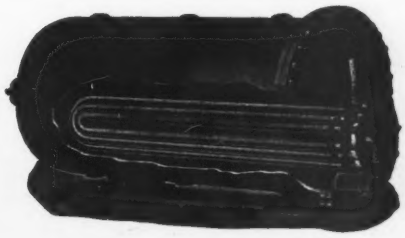
the non-clog works all the time at full capacity, the pond is never shut down, a plentiful supply of cooling water is assured, and a high vacuum steadily maintained with lowest pumping cost.

If you want these conditions for your plant, then you want the Badger. Practical operating pressures range from 3½ to 10 lbs. Write us today.

E. B. BADGER & SONS COMPANY

Boston, Mass.

New York Office: 101 Park Ave. Established 1841



Versatile

The National U-Bend Type Storage Heater gives you intermittent or continuous hot water using live or exhaust steam. It's adaptable to your particular hot water requirements. The cost of operation and maintenance is exceedingly low.

Write for Bulletin No. 65

THE NATIONAL PIPE BENDING CO.

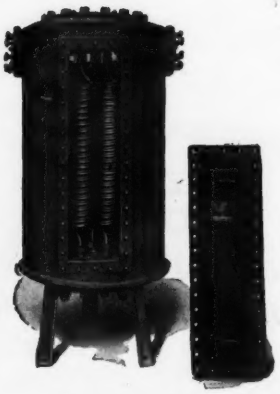
160 River Street

NEW HAVEN, CONN.

Canadian Sales Representative: Grant E. Cole Co. Toronto, Ont. 8700

Increase Your Boiler Capacity

by heating your boiler feed to within a few degrees of the steam temperature with the



REILLY

Feed Water Heater

Besides increasing steaming capacity by preheating the boiler feed, a Reilly Heater installation increases the life of the boiler by preventing needless shock and internal stresses due to the admission of cold feed water into the boiler, and also reduces fuel bills by using exhaust steam that would otherwise be wasted.

Send the coupon for full information

THE GRISCOM-RUSSELL COMPANY

2141 West Street Building, New York

Philadelphia	Detroit	St. Louis	San Francisco
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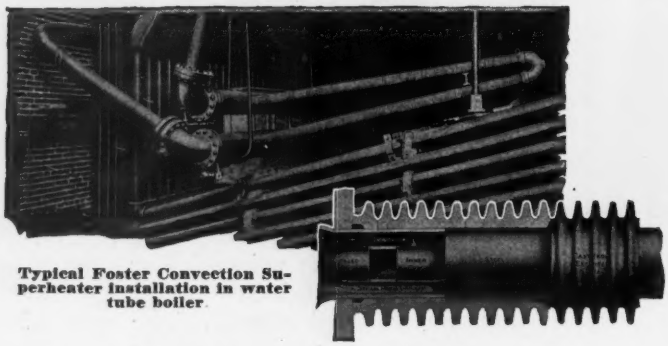
Please send a copy of your Bulletin No. 260. P.P.E. 12-15-25

Reducing power costs in every industry



Typical Foster Convection Superheater installation in water tube boiler

For better plant economy

The fact that superheated steam will save from 5 to 20 per cent in terms of fuel consumed has been largely established through the operating records of the 10,000 Foster Superheater installations extending over 20 years of service.

Superheating has long been known to be one of the most economical means of improving power plant economy. In the boiler, superheating abstracts additional heat from the furnace gases; in the pipe lines, it reduces condensation losses; and in engines and turbines it enables a given weight of steam to do more work. The low initial cost, negligible upkeep, thorough reliability and marked improvement in boiler and engine economy of the thousands of Foster installations have caused the Foster Superheater to be generally regarded as standard equipment for the up-to-date and efficient plant.

In the interest of better economy in your plant, write for the Foster Superheater Book and tell us your operating conditions so we can give you exact figures—without obligation—on your possible savings.

POWER SPECIALTY COMPANY

Foster Economizers and Superheaters

111 Broadway, New York

Boston Philadelphia Pittsburgh Chicago San Francisco
Kansas City Detroit Dallas Denver London, England
Plants at Dansville, N. Y., and Egham, England

102

A few users of Foster Superheaters

Paper	West Virginia Pulp & Paper Co.
Copper	Phelps Dodge Company
Zinc	New Jersey Zinc Co.
Aluminum	Aluminum Co. of America
Lead	National Lead Co.
Central Sta.	Cons. Gas, E. L. &P. Co.
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Nickel	International Nickel Co.
Gold	Homestake Mining Co.
Coal	Consolidated Coal Co.
Coke	Sement Solvay Co.
Oil	Standard Oil Co.
Cement	Alpha Portland Cement Co.
Harvesters	International Harvester Co.
Plows	Oliver Chilled Plow Co.
Fertilizer	American Agricul. Chem. Co.
Automobiles	Packard Motor Car Co.
Tires	Firestone Tire & Rubber Co.
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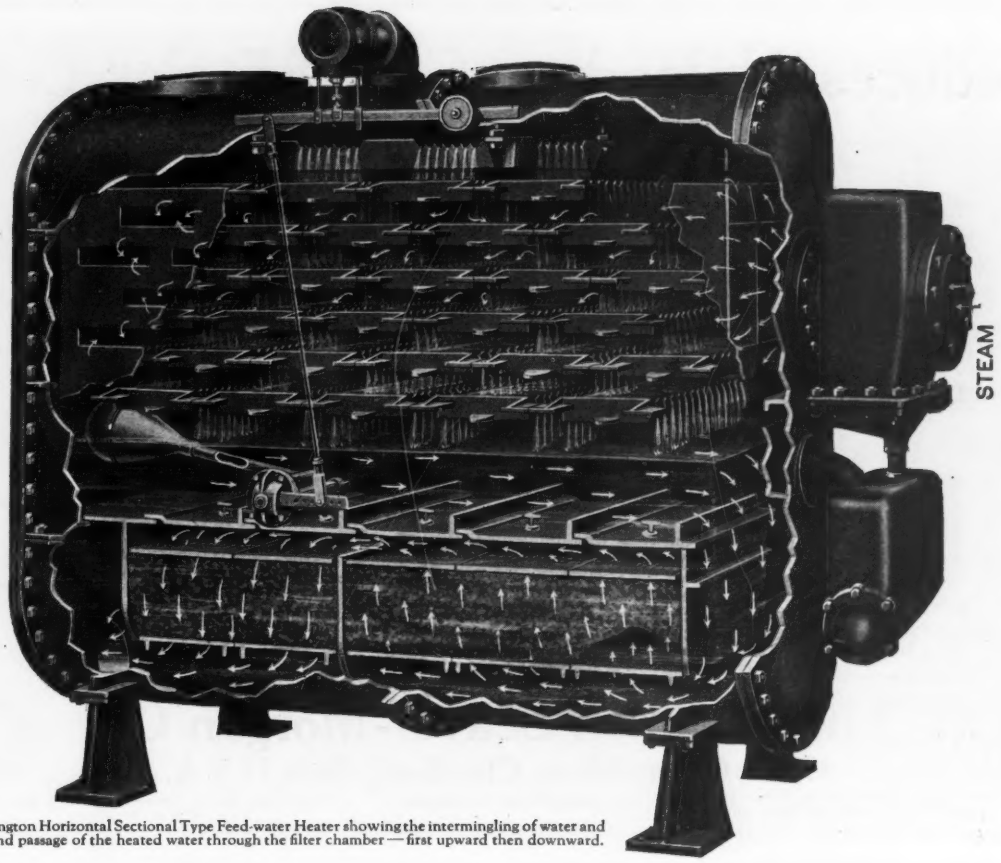
Why they use Foster Superheaters

1. A steel tube for strength; a cast iron shell for durability.
2. Four to six times more heat absorption surface as obtained from bare tubes.
3. Reserve heat stored for sudden demands.
4. Least space for desired superheating effect.
5. Steam stays close to hot tube surface.
6. Can be applied to any make or type of boiler.

FOSTER

The SUPERHEATER

with the extended surface



Worthington Horizontal Sectional Type Feed-water Heater showing the intermingling of water and steam and passage of the heated water through the filter chamber — first upward then downward.

Easy cleaning

insures maintenance of feed-water quality

Ample means of access to the interior of the Worthington Open Feed-water Heater are provided so that the filter may be readily charged or cleaned, or the heating trays removed for cleaning. Flushing of the filter beds is easily accomplished, adding to the effectiveness and prolonging the life of the filter material.

This facility with which the Worthington Open Feed-water Heater can be cleaned insures the attention so essential to the maintenance of purity of the feed water.

Other features of the Worthington heater which have contributed to its popularity are thorough intermingling of steam and water; rustless steam-tight joints and double filtering effect.

In a non-condensing plant the use of a Worthington Feed-water Heater results in a saving of about 15 per cent. of the coal bill, in addition to effecting a substantial saving in labor. In a condensing plant, the condensed steam is passed through the heater and its temperature raised by utilizing the exhaust steam from auxiliaries. A saving in make-up, or cold water, as well as in fuel is thus effected

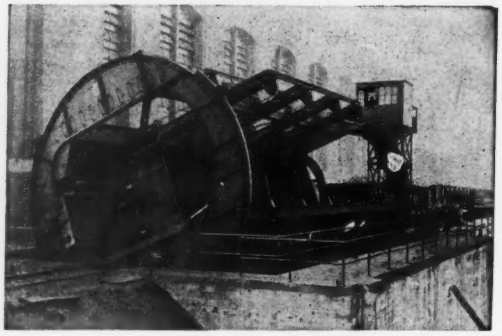
Obtain the benefits of these savings. Descriptive literature will gladly be sent on request.

WORTHINGTON PUMP AND MACHINERY CORPORATION 115 BROADWAY, NEW YORK CITY BRANCH OFFICES IN 24 CITIES

WORTHINGTON

5018-2

Reduces Unloading Cost 85 Per Cent



RECENT PURCHASERS
The Koppers Co. for Bethlehem Steel Co.
The Koppers Co. for Commonwealth Edison Co. (2 Plants)
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"The Wellman-Seaver-Morgan rotary car dumper installed in December, 1923, has reduced our cost of unloading coal from an average of $.11 to $.017. This mechanism has performed to our complete satisfaction and its work has been in keeping with the successful operation of other Wellman - Seaver - Morgan equipment."

This statement is taken from the report of a firm of outside engineers who have recently completed a survey of the performance of this latest development in Car Dumpers.

It is an interesting story for executives seeking possible savings in their own plants.

A copy will be sent upon request.

The Wellman-Seaver-Morgan Co.

7003 Central Ave., Cleveland, Ohio, U.S.A.

Associated Companies: The Wellman Smith Owen Engineering Corp., Ltd., London, England. Wellman Smith Owen (France) Soc. Anon., Paris, France.

COAL HANDLING EQUIPMENT

FROM THE CAR TO THE BOILER

The Illustration Shows

Weller Equipment

Handing coal in a power plant, Rochester, N. Y.

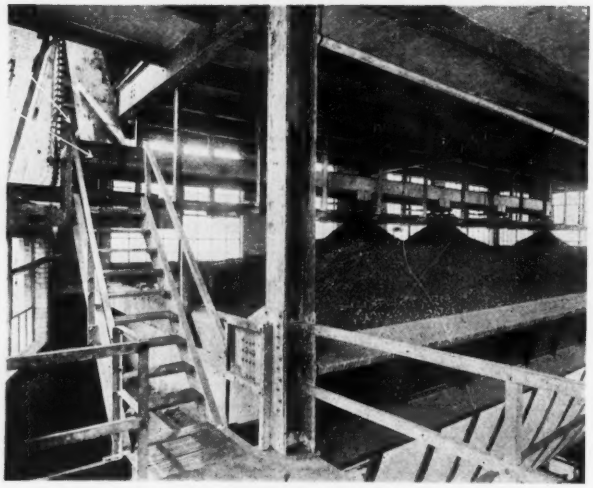
Coal is dumped into a hopper from which it is fed by a reciprocating feeder to a bucket elevator.

The bucket elevator delivers the coal to a spiral conveyor which distributes it in overhead bins and fed to furnace by gravity as required.

This installation is saving

Time, Labor and Money

Submit Your Problem Our Engineers Are at Your Service.



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A Few of Weller Products:

Track Hoppers
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Coal Crushers
Belt Conveyors
Trippers
Spiral Conveyors
Screens
Bucket Elevators
Bucket Conveyors
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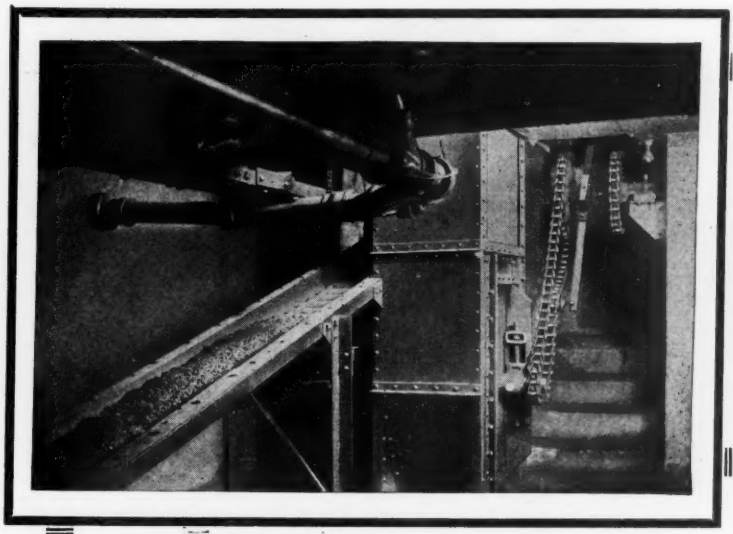

Stearns Drag-Conveyor and Bucket Elevator which form part of the Coal and Ash-Handling Installation in the Power Plant of The Independent Towel Supply Co., Cleveland, Ohio

"This Stearns Equipment Saves Us 75% of Handling Cost," says Power Plant Superintendent

WHEN Mr. E. E. Harr, superintendent of the power plant of The Independent Towel Supply Co., Cleveland, Ohio, selected STEARNS Equipment to solve his coal and ash-handling problem, his decision was in keeping with his determination to make this the most efficient plant of its kind in the Middle West.

"Haven't had a minute's trouble all the two years we've had it," is his comment. "What's more, it's saving us 75% of the cost of the old hand-shoveling."

Complete Installations of

BELT CONVEYORS
BUCKET ELEVATORS
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SCREW CONVEYORS
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MESSITER CONVEYOR SCALES
HOLOTILE STORAGE BINS
STEARNS STANDARD TROUGHING IDLERS AND RETURN ROLLERS,
Etc., Etc.

How Much Handling Cost Could We Save YOU?

STEARNS EQUIPMENT USED

Coal is unloaded at street-level into elevator-boot in basement; thence raised 54 ft. by bucket elevator to drag-conveyor (63 ft. long), which discharges into coal bunkers through gates in conveyor track. The ashes are raked out on to a similar conveyor, 53 ft. long, alongside the ash-pit doors, and pass by bucket elevator to ash-hopper till removed by motor truck. The truck driver receives the ashes on the outside of the building through a chute 9 ft. above street-level, controlling the discharge by a switch on end of chute. A single motor with two-way clutch operates either coal or ash equipment as desired.

Write for Catalog 102-E

STEARNS MATERIAL HANDLING METHODS

The Stearns Conveyor Co.

Main Office & Works: St. Clair Ave. at East 200th St.

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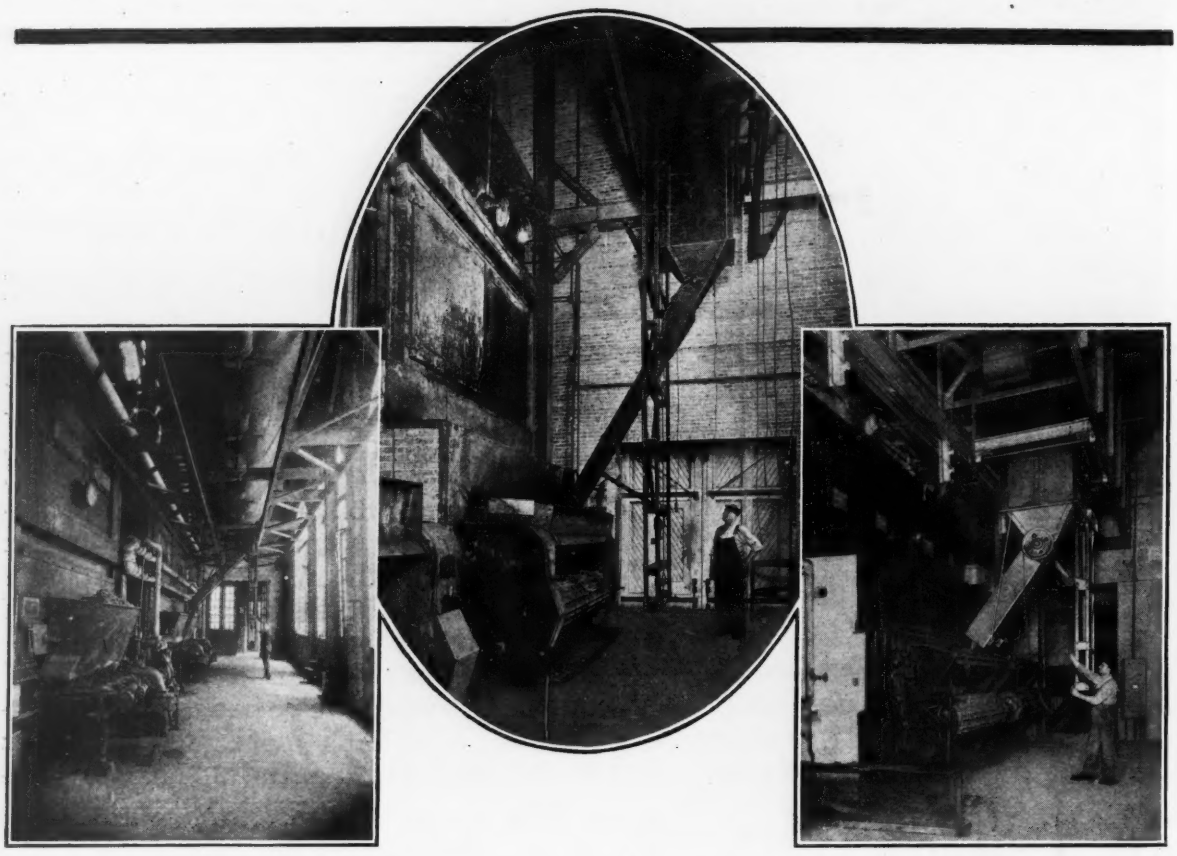
WEBSTER



Save Fuel and Labor with a Webster Weigh Larry

The present agitation for higher efficiency in the boiler room is an economic demand that competitive conditions in modern industry have made necessary. Costs for *power* must be as carefully computed as other manufacturing costs.

Webster coal and ashes handling machinery in the boiler room saves both fuel and labor and makes a clean, orderly boiler plant, easy to maintain at all times.

With a Webster Traveling Weigh Larry accurate fuel consumption records can be constantly kept on each boiler. These weigh larries are both a distributing and weighing device.

Webster Weigh Larries are built to suit power plant conditions and in sizes from 500 to 5,000 pounds capacity or larger, and in hand or motor operated types.

Let Webster engineers go over your plant requirements
Their recommendations will not obligate you

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SEATTLE, WASH.

THE WEBSTER MFG. COMPANY
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CONVEYORS

FOR ANY
COAL AND ASH
HANDLING
JOB
CONSULT
STEPHENS-
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EVERY MODERN
BOILER ROOM
DESERVES
S-A EQUIPMENT

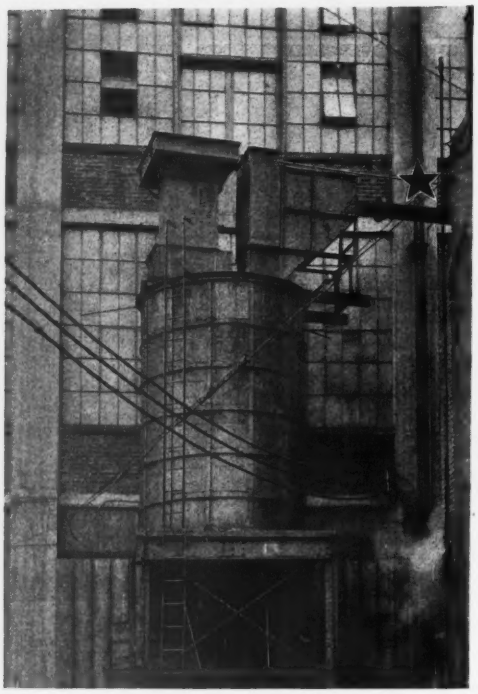
S-A FLOOR TYPE
WEIGH LARRY
FOR THE
BOILER ROOM

STEPHENS-ADAMSON

Stephens-Adamson Mfg. Co.
AURORA, ILLINOIS and LOS ANGELES

American Steam Jet Conveyor Systems

~ Ash and Soot Disposal and Storage ~



Maximum EFFICIENCY CAPACITY SATISFACTION

Minimum STEAM COST LABOR COST REPAIR COST

★ DUSTLESS OPERATION

★ Manufacturing processes in this plant and surroundings positively require dustless ash disposal. Note expanse of glass and open windows. Results guaranteed when sold. Consulting Engineers state "Results from this American system completely satisfactory and have removed all our doubts as to method." Name on request.

Designed, built and sold to conform to purchaser's requirements and expectations as to operating results. Performance the first consideration. Write for Publication P. E.

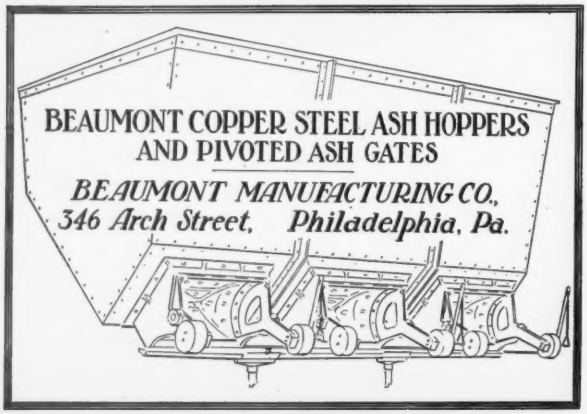
CONVEYORS CORPORATION of AMERICA

5 North Market St. Chicago, Ill.

Representatives in All Principal Cities

BEAUMONT COPPER STEEL ASH HOPPERS AND PIVOTED ASH GATES

BEAUMONT MANUFACTURING CO., 346 Arch Street, Philadelphia, Pa.



HAGAN

Steam Jet Ash Conveyors

The proven economical method of Ash Disposal

Write for complete information

GEORGE J. HAGAN COMPANY

Chamber of Commerce Bldg. Pittsburgh, Pa.

ASH *Products Include*

Ash Gates—Sectional Cast Iron Hoppers—Standardized Ash Sluicing Systems — Ash Quenchers for all types of Hoppers—Cast Iron "Catenary Curve" Coal Bunkers — Ash Storage Bunkers — Air-Cooled Bottoms for Powdered Fuel Furnaces.

THE ALLEN-SHERMAN-HOFF CO

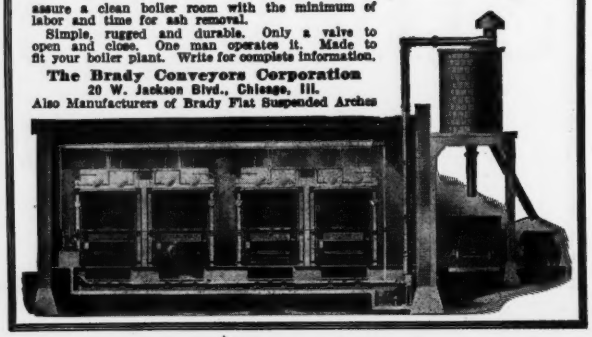
261 So. 15th St., Philadelphia, Pa.

BRADY Steam Jet Ash Conveyors

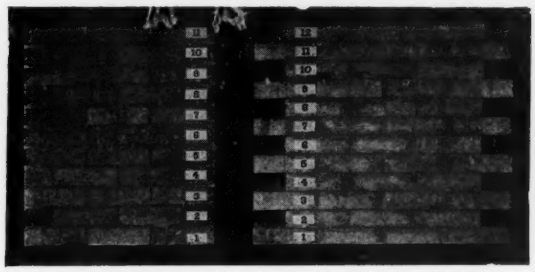
assure a clean boiler room with the minimum of labor and time for ash removal.

Simple, rugged and durable. Only a valve to open and close. One man operates it. Made to fit your boiler plant. Write for complete information.

The Brady Conveyors Corporation
20 W. Jackson Blvd., Chicago, Ill.
Also Manufacturers of Brady Flat Suspended Arches



Build Furnace Walls Right



THE WRONG WAY
89% Brick
11% Fire Clay Joint

THE RIGHT WAY
97% Brick
3% HYTEMPITE Joint

HYTEMPITE

(Reg. U. S. Pat. Off.)

forms a lasting union between refractories. The strong thin HYTEMPITE joint bonds at normal atmospheric temperature and the bond extends through the entire thickness of wall or arch. The strength of the bond is increased by heat up to temperatures at which the best quality of fire brick will soften or fail.

HYTEMPITE is shipped in plastic form — ready for use. A barrel (800 lbs.) will lay 2000 brick.

HYTEMPITE is carried in stock for immediate delivery by our distributors in every industrial center.

Ask for new Bulletin—Hytempite in the Power Plant

Quigley Furnace Specialties Co., Inc.
26 Cortlandt Street NEW YORK

NO MORE OF THIS

Falling Bricks and Cracked Linings Are Successfully Eliminated by Using

BETSON'S PLASTIC FIRE BRICK

It makes possible and practical one-piece furnace linings—no joints. Lasts two to seven times as long as linings built up of separate fire brick.

A plastic refractory product that stands 3100 deg. F. Resists erosion and the action of the gases of combustion. Prevents in-leakage of cold air.

Eliminates shut-downs and overtime repair work.

A trial on repair work will completely convince you of its value for entire new linings.

Shipped from nearest factory or warehouse in distinctive yellow top steel barrels, wet or dry, ready for use.

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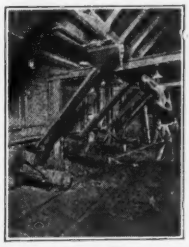
"If it isn't Betson's, it isn't Plastic Fire Brick"

Holeproof Hosiery depends on UNITED Steam Jet Ash Conveyor



Like many other eminently successful firms they selected United Steam Jet Ash Conveyors after "due consideration of other makes" and then found it gave them "No trouble at all." See pages 26 and 27, bulletin No. 105, for letter and illustration on this installation. Write for free copy to United Conveyor Corporation, 381 Old Colony Bldg., Chicago, Ill., New York City, Room 403, No. 1269 Broadway.

Send For Your Copy Today!

This booklet contains a number of suggestions that will help you get greater life from your fire brick. Ask for a copy for each man in your organization who is interested in better brickwork.

BOTFIELD REFRACTORIES CO.
776 S. Swanson St., Philadelphia, Pa.
New York Office: 110 W. 34th St.

Whenever You Use A Fire Brick, Use

ADAMANT FIRE BRICK CEMENT

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American

Brick Chimneys Boiler Settings

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FOR all power plant and industrial requirements.

Designed and erected by men of 25 years' experience.

Let us solve your chimney problems. No obligation for sketch and cost estimate. Write for new catalog.

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15 Modern Refractory Plants with a Capacity of 1,000,000 Brick Per Day

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Carey Insulations are used by the following well known plants:

Carey Multi-Ply — The Ford Motor Company; The Carnegie Steel Company; The Pullman Company. Carey Carocel — The American Radiator Co.; The Pennsylvania Ry. Co.; The Goodyear Rubber Co. Carey Hi-Temp — Cahokia; Hellgate; Devon; Philo; Miami Fort, and many other large central stations.

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These fuel-savers—Carey Hi-Temp, Carey Multi-Ply, and Carey Carocel — completely meet the covering requirements of the full range of steam temperatures.

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Carey Carocel is a laminated asbestos covering of open texture recommended in preference to all other coverings for medium and low pressure lines.

There is a Carey heat insulation to serve every need of industry for heat conservation. Write on your business letterhead for technical data and tests on the type of heat insulation you require.

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Carey HEAT INSULATIONS

For every need —from residence to super power plant

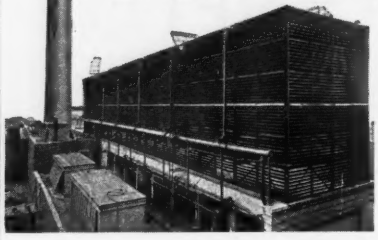
Longer Life for Cooling Towers

The life of a costly cooling tower is painfully short unless the metal surfaces are protected with the right kind of paint.

BITUMASTIC Solution is the ideal paint for this application, as it has great durability under water as well as when exposed. BITUMASTIC is one of the few paints which will adhere to new galvanized metal.

BITUMASTIC
SOLUTION

BITUMASTIC is highly effective in painting old towers because it fills every pin hole and crevice, making an impermeable surface. BITUMASTIC is used on two-thirds of the cooling towers in Philadelphia, including that of the Wilbur Chocolate Co. shown at left.



Write for sample can.

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"Refractories and Furnace Design" tells how to prevent bulging of walls and falling of bricks—how to cut heat loss through the setting—how to do away with high-priced masons for lining installation, and with the stocking of special shapes—how to make repairing easy.

Write for your copy of this 32 page book to the Plibrico Jointless Firebrick Co., 1136 Clay Street, Chicago.

free!

Reg. U. S. Pat. Off. **THERMOLITH** Pats. Pndg.

The All Temperature Fire Cement

"Makes the Weakest Point the Strongest"

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Trade Mark
HARBISON-WALKER REFRACTORIES CO.
World's Largest Producers of Refractories
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Two Linings or One?

Which is the most profitable to the power plant? If you paid **half** as much for one kind of fire brick that lasted half as long as another kind, you would **still be out money** on your linings, wouldn't you?

Time and expense while boiler is shut down, old lining torn out and new lining laid up are the big costs on furnace linings.

Our brands of fire brick, placed into service in thousands of plants during the last 89 years, are made to endure.

"Q. R. GLASS" linings often last three times as long as ordinary fire brick linings.

Stand up in flat arches. Uniform and free from shrinkage, pitting, spalling. Resist abrasion. Ideal for high temperatures.

Write for "Catalogue," and your copy of "Some Interesting Facts."

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Double-Suspension Arch
Single-Suspension Arch
Interlocking Fire Brick Wall

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Consider their endurance

Of best materials and construction, they give husky service. Can be repaired without disturbing other tile or brick work. Write.

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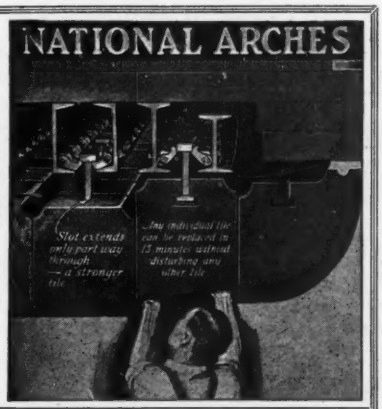
NATIONAL ARCHES
Slot extends only part way through —a stronger tile
Any individual tile can be replaced in 15 minutes without disturbing any other tile

Ramtite comes in clean, new tongued and grooved barrels which preserve it in perfect condition, ready for immediate use.

Every barrel of

RAMTITE

saves many times its cost in fuel!

Send for this 20-page treatise on High Temperature Refractories. Free on request. Write for your copy.

NOT how little, but how much RAMTITE you can use in your plant is the problem. Because in hundreds of plants it has proved a real fuel saver.

Used to repair old linings or to build new monolithic linings, Ramtite makes the furnace tight and it remains tight, saving fuel and improving combustion.

Just on the basis of lining costs alone it is a dividend payer that you should try at once.

Fifty years of specialization created this remarkable refractory material, now accepted as standard by plants in all parts of the country.

Plastic and ready to use. Order a barrel now or write for booklet.

THE S. OBERMAYER CO.
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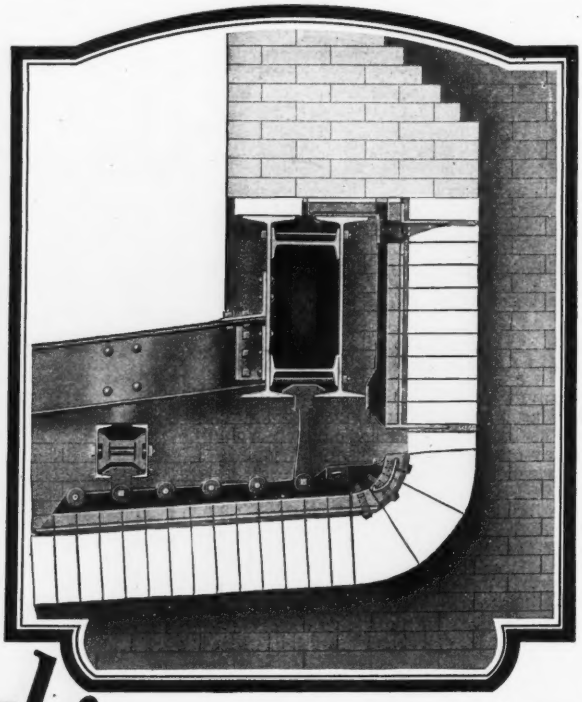
Established 1874
Stock carried at Chicago and other principal cities

Ramtite made this smooth, tight, enduring lining, as shown at left. Applied with a mallet and trowel by any handy man about the plant. Equally useful for Boiler Settings, complete; Furnace Linings; Combustion Chamber Arches and Walls; Furnace Floors; Deflecting Piers; Wing Walls; Baffles; Door Linings; Flue Linings, etc.



Over 8,500 Installations

How's this for simplicity?

WHERE else can you find the mechanical simplicity of Detrick?

Detrick installation is simplicity itself. Complicated arrangements do not exist in Detrick engineering. Any part of the arch is quickly reached and repaired and in every Detrick Arch, the freedom from many shapes of tile is noticeable.

Detrick simplicity plays a large part in reduced upkeep costs — a large part — and Detrick Arches play a large part in reducing power plant costs—that's why the big plants are coming to Detrick.

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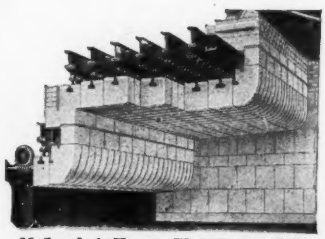
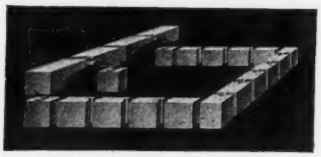
DETRICK
Flat Suspended
ARCHES

PPE 12-15R-RTG

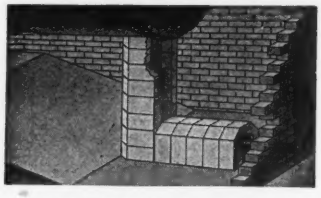


McLeod & Henry Flat Suspended Furnace Arch



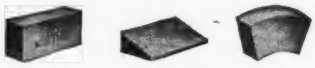
STEEL MIXTURE *Fire Box Blocks and Boiler Door Arches*

Back Combustion Chamber Arch



Blow-Off Pipe Protection

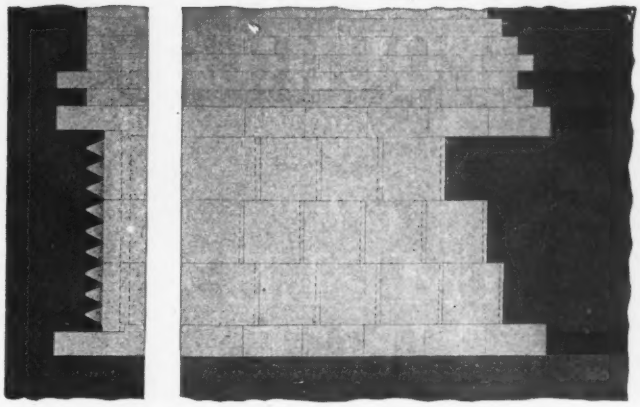
Boiler Baffle Tile



Standard Fire Brick and Special Shapes

STEEL MIXTURE

REG. U.S. PAT. OFF.



Air-Cooled!

STEEL MIXTURE Air-Cooled Furnace Lining provides for circulation of air behind the fire wall, thus keeping the temperature down to a point where the surface exposed to the fire will not fuse or become fouled with clinkers. This is accomplished without appreciable effect on combustion economy, but the cooling air can if desired be routed for delivery in such a way that the contained heat is fully utilized.

The passage for air circulation behind the furnace wall is provided by a group of pyramids on each STEEL MIXTURE Block, the space betwen the pyramids forming a duct for the passage of air. This construction offers great flexibility in installation, as the air-cooling effect can be obtained wherever desirable in the furnace wall, and the blocks can be applied as readily in repairing an old furnace as in setting up a new one.

A new booklet on this subject is ready for distribution.

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McLEOD & HENRY CO.

Specialists in Furnace Refractories for One Hundred Years

Main Office and Works, TROY, N. Y.

Branches: **New York, Boston, Cleveland, Detroit**

OUR HUNDREDTH BIRTHDAY

The Phoenix and Salamander Fire Brick Works, which in 1877 became the McLeod & Henry Co., was founded by Jacob Henry in 1825. Abraham Lincoln was then 16 years old. Ulysses S. Grant was 3. Jefferson Davis and Robert E. Lee were youths of 17 and 18 years respectively. Daniel Webster was 43 and Henry Clay 48 years old in 1825.

FREE BOOKLETS

Any or all of the following booklets will be sent on request. ✓ Just check the ones that you want and mail this coupon.

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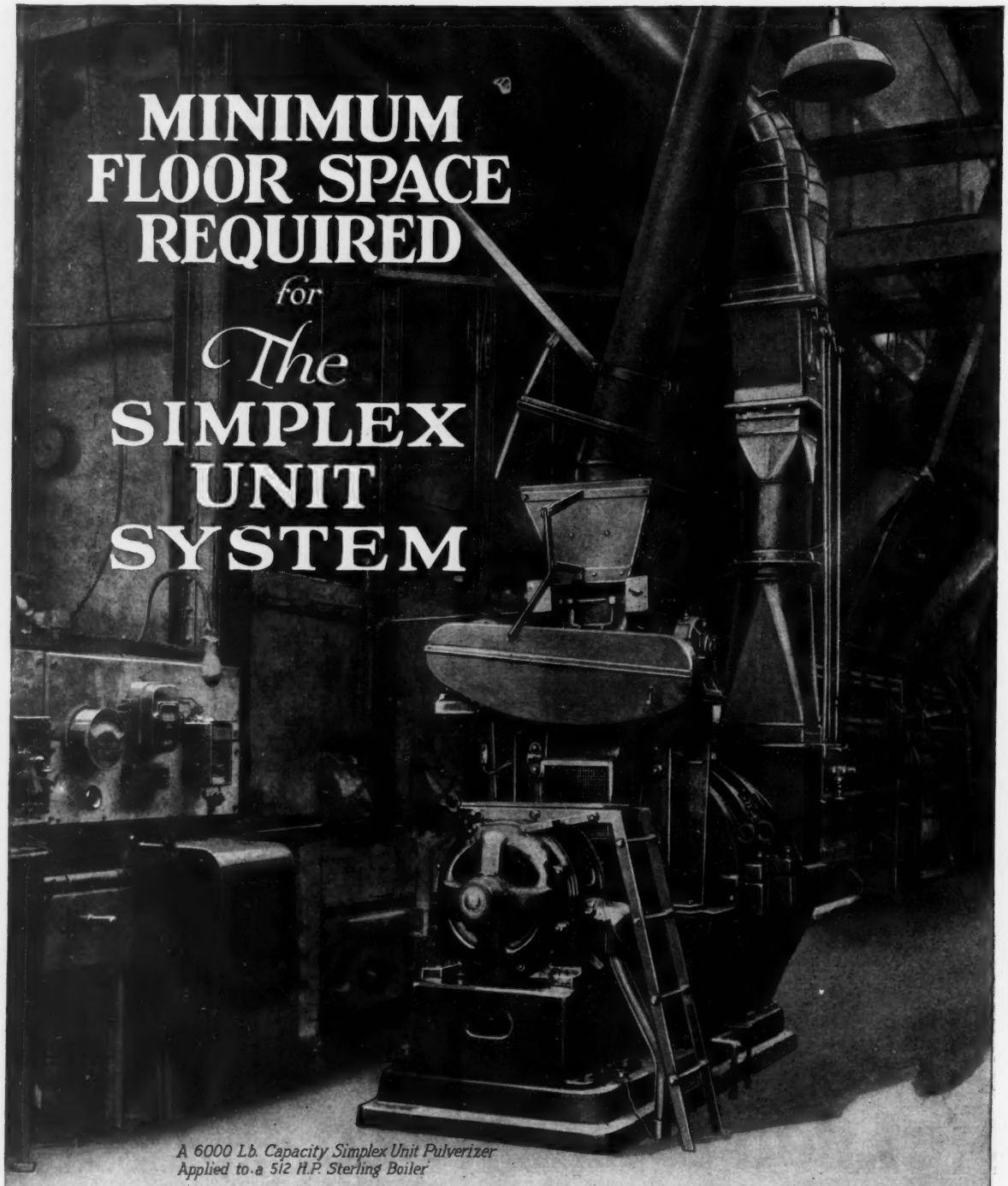

A 6000 Lb. Capacity Simplex Unit Pulverizer Applied to a 512 H.P. Sterling Boiler

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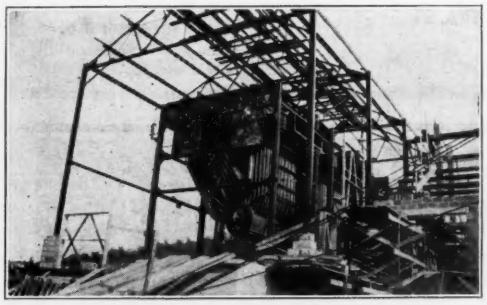
Review the History of the Erie City Iron Works—

BACK through long years of service—a decade, a quarter of a century, the half century mark—still further back to a period of simple days and simple tastes—back, if you please, to 1840.

Even in those early times, Erie City Iron Works was placing its engineering knowledge at the disposal of power users, building the secure foundation for the **completeness of service** now available through this organization.

To past generations, the name of this company was a familiar one. Its advice was sought. Its high standards of manufacture were known and recognized.

Always has Erie City equipment been looked upon as a **means to an end**—to insure higher efficiency, greater economy. And today, with years of engineering and manufacturing experience behind us, this company pledges all its vast resources toward a greater willingness to serve—a willingness to go into every phase of a power user's problem and find the accurate solution, expressed in definite economies and performance.



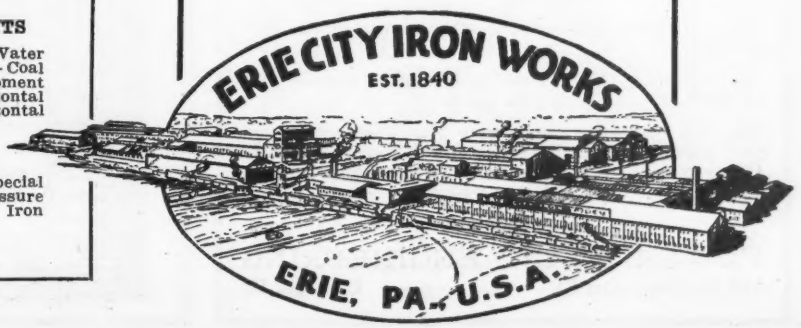
100 Per Cent Dry Steam

The above illustration pictures an **Erie City Three-Drum Inclined Water Tube Boiler** during the course of erection. A unique arrangement of established principles of boiler design assures 100 per cent dry steam, freedom from priming, greater flexibility, greater accessibility and greater economy.

Like all Erie City products, the Three-Drum Boiler is a means to an end.

MODERN STEAM POWER PLANTS

Unitype Powdered Fuel Equipment—Water Cooled Refractory Lined Furnaces—Coal Sizing, Separating and Handling Equipment—Boilers, Inclined, Vertical and Horizontal Water Tube—Boilers, Economic Horizontal and Vertical Fire Tube—Boilers, Heating, Portable, Marine and Special—Engines, Lentz Poppet Valve Counterflow—Engines, High Speed, Variable Speed, Vertical Slide Valve—Special Equipment for Industrial Plants—Pressure Vessels, Tanks and Tank Cars—Grey Iron Castings.



The Taylor Stoker

The Simplest, most Efficient, most Economic System of Combustion for Central Stations and Industrial Power Plants

AMERICAN ENGINEERING COMPANY
Kensington Station, PHILADELPHIA, PA.

Manufactured in Canada and sold by AFFILIATED ENGINEERING COMPANIES, Ltd.
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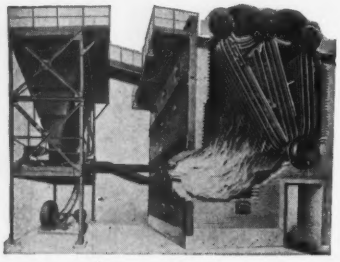
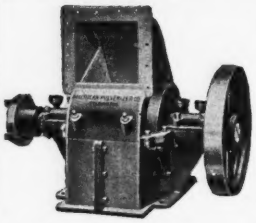


Fuel
Labor
Linings
Money

Write for Bulletin 900E

Fuller-Lehigh Company, Fullerton, Pa.



Besides our Coal Crushers, the American Ring Crusher shown above, to make old firebrick available for new, plastic linings, is a paying investment.

Good Performance of American *Ring* Crushers

makes them valuable in all industrial and power plants. Write for information.

American Pulverizer Co.
18th and Austin Streets
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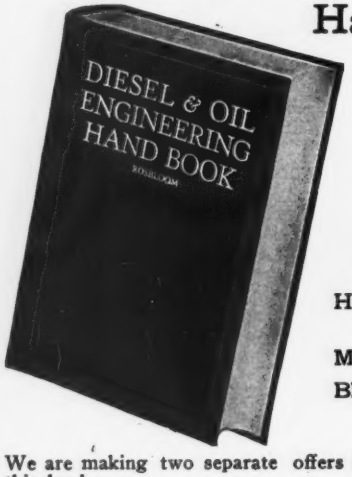
Diesel and Oil Engineering Hand Book



by

Julius Rosbloom

800 pages
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Many Illustrations, Blueprints, Charts.

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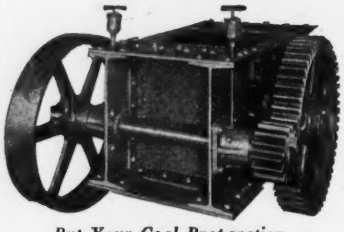

are specialized for properly preparing R. O. M. Bituminous coal for modern stokers and pulverizers in Industrial Power Plants, Gas Works and Central Stations, **with unfailing dependability.**

Put Your Coal Preparation Problems Up to Us

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NEEMES

Neemes Improved Shaking and Dumping Grates have for 51 years been the choice of careful and discriminating buyers because any kind of coal can be burned on them with the best possible combustion.

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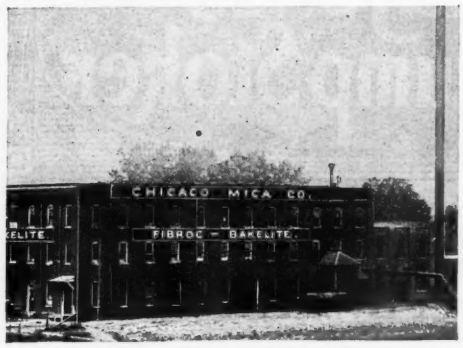
186 First Street Troy, N. Y.
Manufacturers of Round and Square Grates
Established 1874

ECONOMY 1874 QUALITY NEEMES SERVICE

GRATES

Boilers 80 H. P. and up should have UNITED "S" Type

Traveling Grate Stokers



Chicago Mica Company at Valparaiso, Ind., repeated their order for a United "S" Type Stoker inside six weeks. They too changed from R. O. M. coal to screenings.

Save $1.00 a ton

writes one user. Another writes his United Stokers saved their purchase cost in one year. Similar savings are possible in your plant.

Send us data on your plant for free estimate

UNITED Engineers have developed the "S" Type Automatic Traveling Grate Stokers to give practical, money-saving service on boilers as small as 80 hp.

Continuous, automatic, even firing, and quick response to load demands are some reasons why United Stokers are used in the plants of Chicago Mica Co., Valparaiso; White Star Laundry, Des Moines; La Porte Gas & Electric Co. (Gas Plant); Allen County Infirmary, Ft. Wayne.

United Stoker users can change to screenings which in one plant gave as good results as R. O. M. coal with the former method of firing. Savings on the purchase price of coal are up to $1.00 per ton.

May we give you more reasons why the small plant should have United Stokers? Built as small as 3 feet wide and 6 feet long. Write

UNITED STOKERS CO., La Porte, Ind.

E. H. Bull & Co., Western Agents, 25 E. Jackson Blvd., Chicago

T. M. Gardner, 814 E. 23rd St., Indianapolis — United Eng. & Sales Co., 210 Crocker Bldg., Des Moines, Iowa — Pittsburgh Machine Products Co., Oliver Building, Pittsburgh, Pa.

Comley-Fauls-Bushfield, Inc., 628 W. Jefferson St., Louisville, Ky.

DETROIT UNDERFEED STOKERS

Ask For Bulletin 879

Detroit Stoker Company
879 General Motors Bldg - Detroit.

for combustion efficiency

of low grade, inexpensive coals and for low upkeep costs, write to the Laclede Stoker Co., 4438 Hunt Ave., St. Louis, Mo., for particulars regarding the

Laclede *Chain Grate* **Stoker**

Gibby Stokers

SUCCESSOR TO FILES STOKER

HAND OPERATED

Whether you are burning Illinois slack or a mixture of anthracite screenings, you can do as your competitors have done—save money with GIBBY STOKERS. Write us at once for full information.

GIBBY ENGINEERING COMPANY
Condor St., East Boston, Mass.

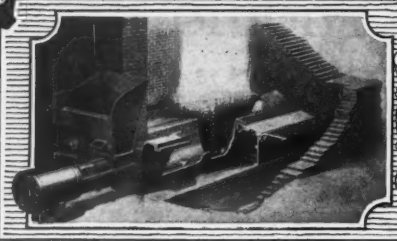
HUBER STOKERS

Mechanical Stoker — Hand Stoker (heavy duty)
Semi-Mechanical Stoker — Hand Stoker

A Stoker For Every Boiler

Send for a copy of
"Five Minutes With the Coal Bill"

FLYNN & EMRICH COMPANY
307 North Holliday Street — Baltimore, Maryland



The JONES "Side-Dump" Stoker

Jones "Side-Dump" Stokers
Pay for Themselves—Then Pay Dividends

This is what they do:

1. **Save Coal.**
   Five hundred tests on Jones-stokered boilers have shown an average saving over hand firing of 19.3%.
2. **Save Labor.**
   Even on the smallest installations, labor is saved. Hand shoveling of coal into the furnace is eliminated. Where suitable coal and ash handling equipment can be installed, the labor is reduced to a minimum.
3. **Increase Capacity.**
   For a plant that has reached the limit of its capacity by hand-fired methods, and more steam is required, either more boilers may be added or stokers may be installed under the existing boilers. A Jones "Side-Dump" Stoker will double the capacity of the boiler, or even more, depending upon the size of stoker, the setting, and other local conditions.
4. **Burn Poorer Grades of Coal.**
   Instead of being obliged to obtain the highest grades of coal as with hand-firing, users of Jones "Side-Dump" Stokers find that they can handle the lower grades of fuel with good results. Beside the reduction in cost of coal, this is also an important consideration in times of coal shortage.
5. **Eliminate Smoke.**
   The Jones "Side-Dump" Stoker is guaranteed to meet all local smoke ordinances. Users of this stoker know that they comply with all smoke laws, and in addition they have the satisfaction of knowing that by so doing they burn coal in an efficient and economical manner.

The Jones "Side-Dump" is made in both steam and mechanically driven types

Riley Stoker Corporation

RILEY STOKER CORPORATION

"RILEY" Underfeed Stokers — "JONES" Underfeed Stokers — "HARRINGTON" Traveling Grate Stokers

"MURPHY" Automatic Furnaces — Pulverized Coal Installations

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Riley Engineering and Supply Co., Ltd., Toronto — Riley Stoker Co., Ltd., London

For Mechanical Stoker Efficiency at lower than "Man-power" cost *investigate*

KELLY IMPROVED HAND STOKERS

Easy to install ~ Easy to operate

NO CLAIMS are made for Kelly Improved Hand Stokers, that properly belong to mechanical stokers.

What we have proved by the service this stoker has given, and we back these claims with our reputation of 38 years' service to power plants, is that the Kelly brings to the medium-sized and small plant ability to burn low grade coals, to meet peak loads, to attain higher overratings and to save 10 to 25 per cent of the fuel without the expense of building a new boiler room or enlarging it, providing mechanical drive or any of the many changes required for a mechanical stoker installation.

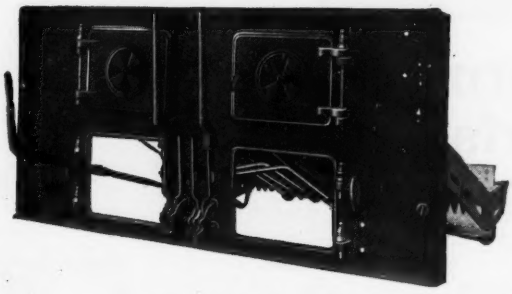
Kelly Stokers reduce the man-power required in firing—they do not increase it. Therefore, firemen like to operate the Kelly and on large installations it actually permits a reduction in the operating force.

From the experience with hundreds of Kelly Grates operating successfully in every coal zone of the country, the system of grate control and lever operation used on the Kelly Improved Hand Stoker was originated.

One of the four levers raised the grate bars shown, which shear clinkers, move fuel forward and clear ash.

Even this easy, convenient, powerful leverage and sectional control is made fool-proof by the balanced bars that are weighted to drop into place as soon as levers are released as you will note in the illustrations and description of operation shown here.

Do not delay your investigation of the Kelly Stoker. Write for full information.



Note vertical dump plate lever at left and the out-of-the-way handle at right for close spaces. Four grate bar levers are grouped between doors.

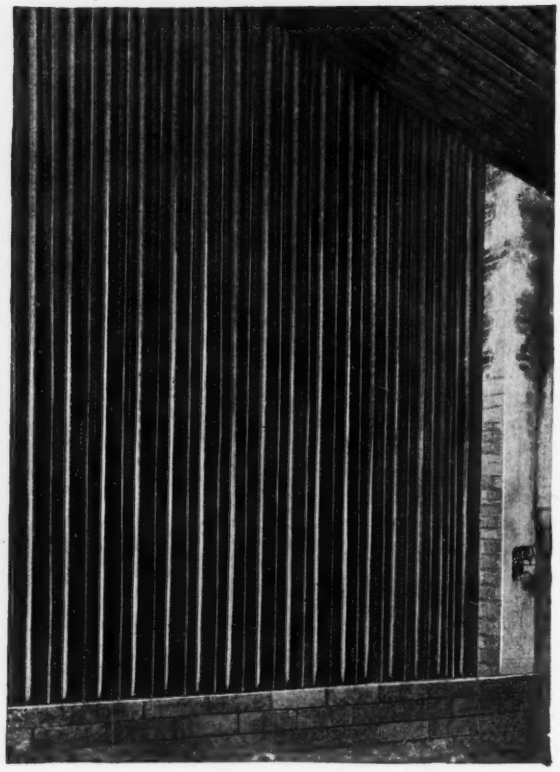
The Kelly Foundry & Machine Co.
617 Ninth St., Goshen, Ind.
POWER PLANT ENGINEERS
NEW YORK OFFICE Established 1887 CHICAGO OFFICE
59 Park Place 111 W. Washington St.

Feature III

FLEXIBILITY — LEVER SYSTEM THAT GIVES PERFECT CONTROL OF FUEL BED — Four levers on the outside of the cast iron front operate the movable grate bars, each lever operating one-fourth of the grate surface — each operating the alternate bars on one side of the grate. Handles are removable — and stand in the center at proper height and connected by powerful leverage for instant use. On the hinged side of each ash door are the dump plate lever handles. Two styles, supplied as preferred, make them adaptable to any layout.

WHEN YOU BUY KELLY STOKERS-GRATES GOSHEN IND. YOU BUY RESULTS

Utilizing De s



With C-E Fin Furnace Walls, radiant heating surface replaces refractory walls.

Combustion

Corpo

Lopulco Pulverized Fuel System
Frederick Multiple Retort Stoker
Self Contained Stoker
Coxe Stoker

Type E Stoker
Type D Stoker
Type K Stoker
Type H Stoker

43 Broad Street, New York

Offices in Principal Cities

e structive Heat

Heat that destroys refractories and escapes through furnace walls by radiation is waste.

C-E Fin Furnace Walls utilize this heat to make steam. C-E Fin Furnace Walls are 100% boiler heating surface.

Heat absorption and evaporation from Fin Furnace Walls are the same as in the first two rows of tubes in the boiler.

Capacities never before approachable become everyday performance.

Engineering

ration

Green Chain Grate Stoker
Green Forced Draft Stoker
C-E Fin Furnaces
Combusco Ash Conveyor

Quinn Oil Burning Equipment
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C-E Direct Fired Unit

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Throughout the World

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All Steel Construction

Vertical or Horizontal Baffle, inside type forged steel handhole plates. Units of any size for any purpose. We also build Horizontal Tubular and Marine Type Boilers.

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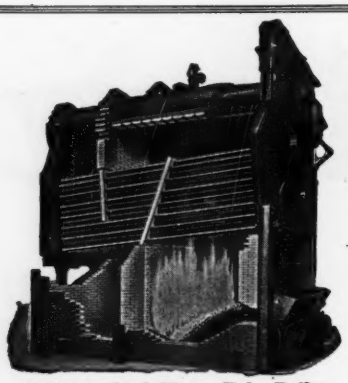
New York Chattanooga Chicago



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Boilers
Preheaters
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Water Cooled Furnace Walls

Each a unit in itself, yet an integral part of the boiler proper. Surveys and Tests by outside Engineers forwarded on request

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"Preferred Workers" for your plant—

Skilled workers for every branch of power production are quickly found through the "Signboard Section." These workers are "preferred"—the kind desired and required to keep plant operation at its best.

Use this effective means of filling any vacancies in your plant. State your requirements in an advertisement—the "Signboard Section" will do the rest.

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CUT FUEL BILLS IN HALF

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For medium and high pressures

ESPECIALLY suitable for large power plants. Steel construction throughout. Straight tubes. All handholes elliptical, their covers internal and removable through their own openings. Unrestricted circulation, permitting forcing of fires with safety and economy.

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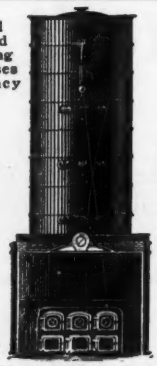
Steel Cased Setting Increases Efficiency



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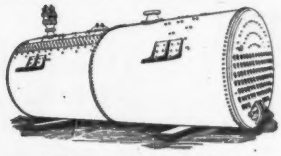
Ask for Bulletins describing in detail—sent free



Horizontal Return Tubular

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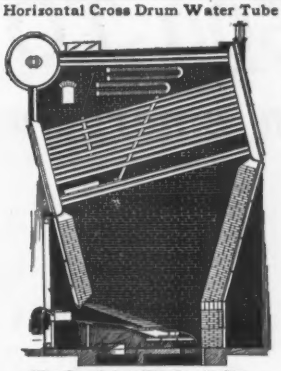
Horizontal Cross Drum Water Tube



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UNION BOILERS

For nearly forty years the **Union Iron Works** have been concentrating in the development and manufacture of high pressure steel boilers exclusively and offer the Union Water Tube Boilers in both the horizontal straight tube longitudinal and cross drum designs and the vertical bent tube types, for pressures up to 400 lbs., in practically all sizes.

Also makers of Horizontal Return Tubular and Union Universal Fire Tube Boilers, having one of the largest and most modern boiler manufacturing plants, with sales representatives in all principal cities to serve you.

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"Modern Valve Control Practice," our latest booklet, discusses electric valve operation and the Dean Valve Control System. A copy of this interesting and informative publication mailed on request.

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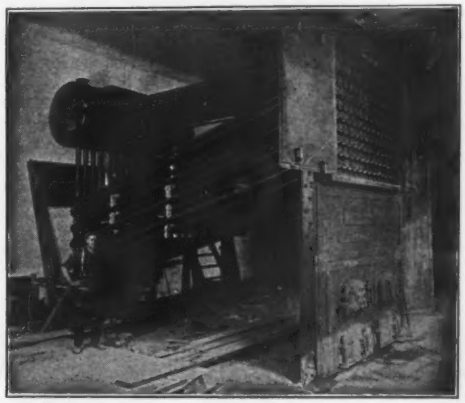
All steel construction.
Built in all H. P. sizes for all pressures.



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500 TOWNS Are Protected

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12 to 300 H. P., at 1200 to 1500 R. P. M.
$20 to $30 a H. P. Paralleling guaranteed.

Sterling Internal Combustion Engines

THE ENGINE OF REFINEMENT

You can't read about a holocaust without considering resentfully what might have been done to guard against it.

Have you a Sterling engine on your emergency unit, to supply light and water when power is down?

Sterling Engine Company
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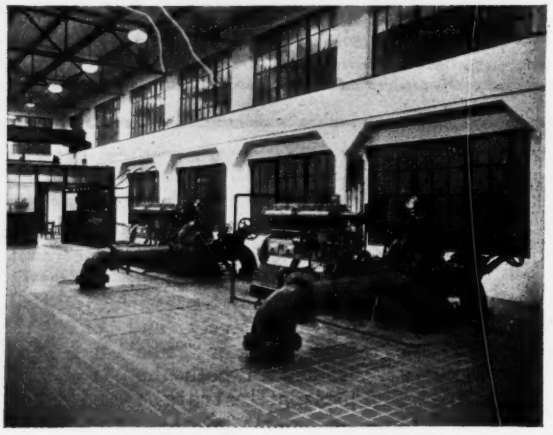

Charlotte, N. C. Two 12-in. single stage De Laval pumps, each 4000 G.P.M., 160 ft. head at 1200 R.P.M., driven by Sterling 240 H.P. engines.

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More than 9000 Terry Turbines now in operation. There is a type to meet your particular needs. Terry engineers are available for consultation and advice on any problem involving the use of a turbine. Write for information, stating your steam conditions and power requirements.

The Terry Steam Turbine Co.
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The
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The Most Economical Steam Engine Ever Built

Built only by
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will be assured if Ridgway motor-generator sets or synchronous converters are installed.

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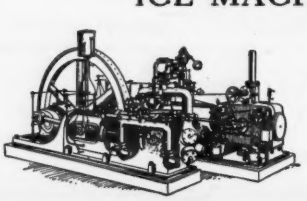
ICE MACHINES



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The Vilter Mfg. Company
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Standard Generator Units

Designed for present-day steam conditions

Standard Turbine Corporation, Scio, N. Y.

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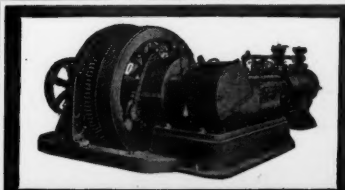

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"BEST AT EVERY TURN"

The Heart of the Boiler Room—

the stoker and fan drives—

That's where you need the power, compactness, dependability and ruggedness that's built into

Troy

Throttling Self-Oiling

Engines

Install this special unit to drive stokers and fans, that is built by specialists especially for the purpose, and forestall trouble, repairs and failures that may shut down the whole plant if less dependable units are used. Economical of steam and sold at a remarkably low price because of quantity production. Write for illustrated Bulletin H.

Type "S-H" 5 to 40 B.H.P.

—the ideal drive for stokers, fans, etc., as it has:

Minimum steam consumption,

Well-balanced strength in all parts,

Correct and permanent oiling system,

Low maintenance and operating cost.

Consult us.

Troy Engine & Machine Co.

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Troy Automatic Self-Oiling Engine (capacities 5 to 200 B.H.P.) direct-connected to electric generator. An economical lighting set for carrying night load and for parallel operation with main units to swing peak loads.

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ENGBERG'S ELECTRIC & MECHANICAL WORKS
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Vertical, Enclosed *Self-Oiling, Steam*

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GENERATORS **MOTORS** **SWITCHBOARDS**

AIR!

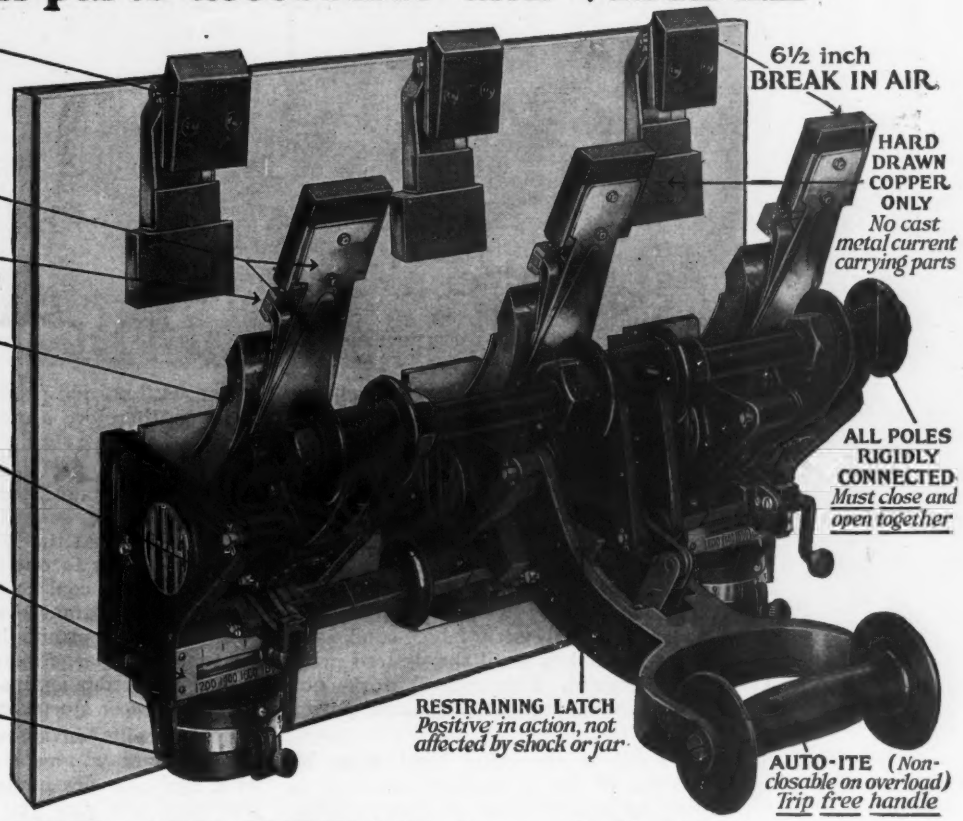
I-T-E CIRCUIT BREAKERS

For Alternating Current

600 VOLTS OR LESS

Give protection without complication

All parts accessible and VISIBLE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For initial contact and final break
Mechanically strong
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PHOSPHOR BRONZE CARBON SUPPORTS
HEAVY METALLIC SECONDARY BREAKING CONTACTS
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Each leaf individually formed - Heavy even pressure on every Lamination
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Afford heavy contact pressure with easy closing
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Direct acting. Long scale calibration. No relays or series transformers
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(Direct acting time limit) feature. Adjustable from zero to maximum time. No relays
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Must close and open together
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Positive in action, not affected by shock or jar
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I-T-E AIR BREAK has definite advantages not present in the oil breaker

1. *No oil — to leak, carbonize, burn or explode — Just air.*
2. *No tanks to conceal anything — or the lack of it.*
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4. *Inherent simplicity — with resulting low cost of installation and maintenance.*

The I-T-E CUTTER COMPANY

ESTABLISHED 1888 PHILADELPHIA

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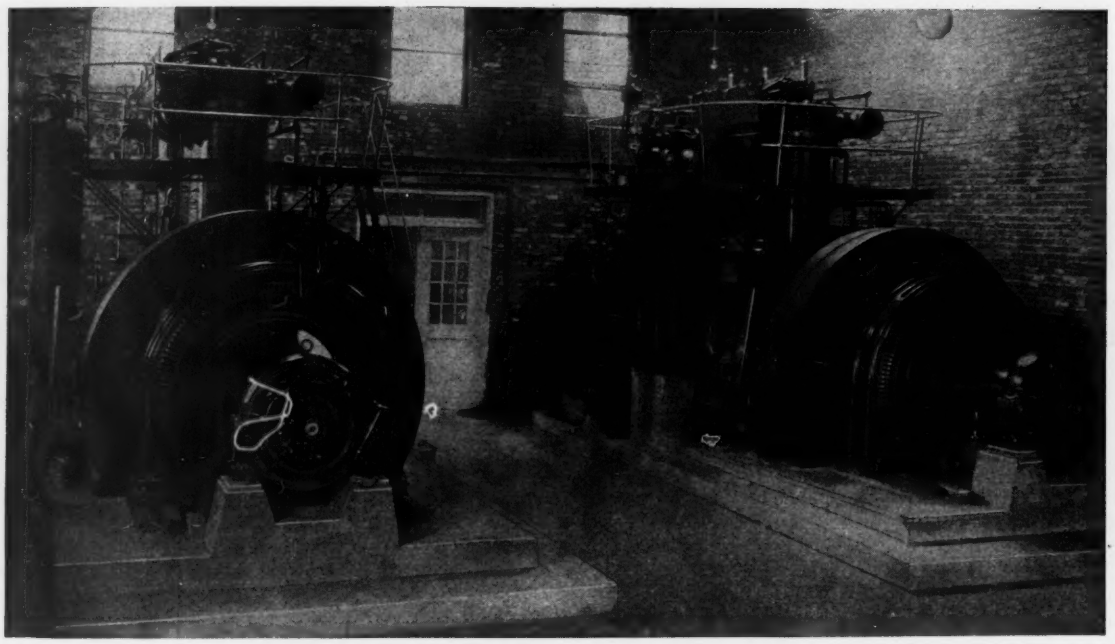

You can laugh at coal strikes if you install Diesel power

COAL and fuel oil are produced and marketed under radically different conditions which tend to make the supply of Diesel fuel the more uniform in quality, the lower in cost and safer from interruption.

During strikes and seasons of low coal demand, the mine owner can shut down without other loss than a small overhead. His coal is safe in the earth under ownership and control until labor conditions become normal or until the desired price can be realized. This control works out to the disadvantage of the steam power plant owner.

Fuel oil, on the other hand, must be taken out of the ground as soon and as rapidly as possible after discovery to prevent loss to the owners through adjoining wells. The "strikes" are the kind that make for a *bigger* instead of a *smaller* supply of fuel. Regardless of market conditions, the maximum production must be sold at once or stored above ground. As tanks cost more than the value of the oil they hold, the amount of oil that can be withdrawn from immediate sale is limited, and price quotations must stay more in line with normal production. Price inflation is therefore a more remote possibility.

The user of Diesel engines and fuel oil has this advantage at the point of fuel production, and derives further benefit from the fact that the Diesel engine uses only one-eighth to one-third the volume and weight of coal to do given work. This makes substantial savings in transportation and permits buying and storing fuel in the large quantities which are also a protection against interruption in times of winter storms or labor shortage.

If you will tell us what amount of steam power you now generate and at what fuel cost per horsepower-hour, our engineers will give you definite dollars-and-cents figures on what fuel saving you could make by using Diesel main or auxiliary power.

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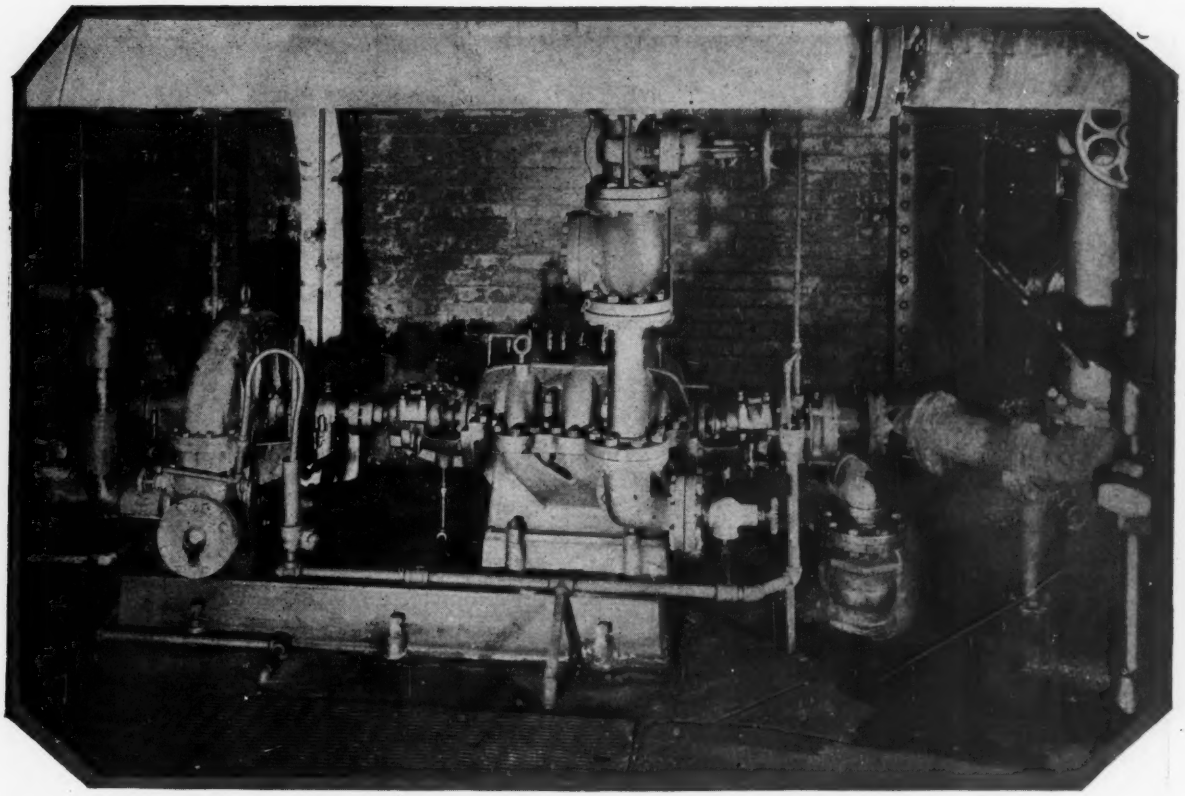
McINTOSH & SEYMOUR DIESEL ENGINES



Sturtevant Steam Turbine driving boiler feed pump at Marion Station, Public Service Electric Co., Newark, N. J.

STURTEVANT STEAM TURBINES

Used For Auxiliary Drive in Many Important Power Stations!

On account of the special features in construction and design, Sturtevant Steam Turbines have been selected for driving auxiliary equipment, in many of the great power plants throughout the country. Sturtevant Turbines differ from other turbines in many respects. Take the construction of the bucket wheel for instance, upon which satisfactory operation rests.

In Sturtevant Turbines the bucket wheel has neither notched nor inserted buckets to allow distortion or permit steam leakage and loss of efficiency. The entire wheel is made from one solid forging of the best open-hearthed steel with the buckets milled into the rim.

The Sturtevant Co. was the first to design and build a solid turbine rotor with milled-in buckets. Blades with notched centers were used at first because at that time the buckets could not be built without the notch which really exists only to accommodate the shank of the milling tool and actually decreases steam economy.

Sturtevant later patented a device which retained a straight edge on the bucket and gave the necessary depth of cut from the blades—something that no one else has yet been able to obtain.

This is just another evidence of Sturtevant leadership in engineering construction and design.

Sturtevant Turbines have many other superior points. Why not send for catalog No. 311 which shows in detail the many advantages of these turbines?

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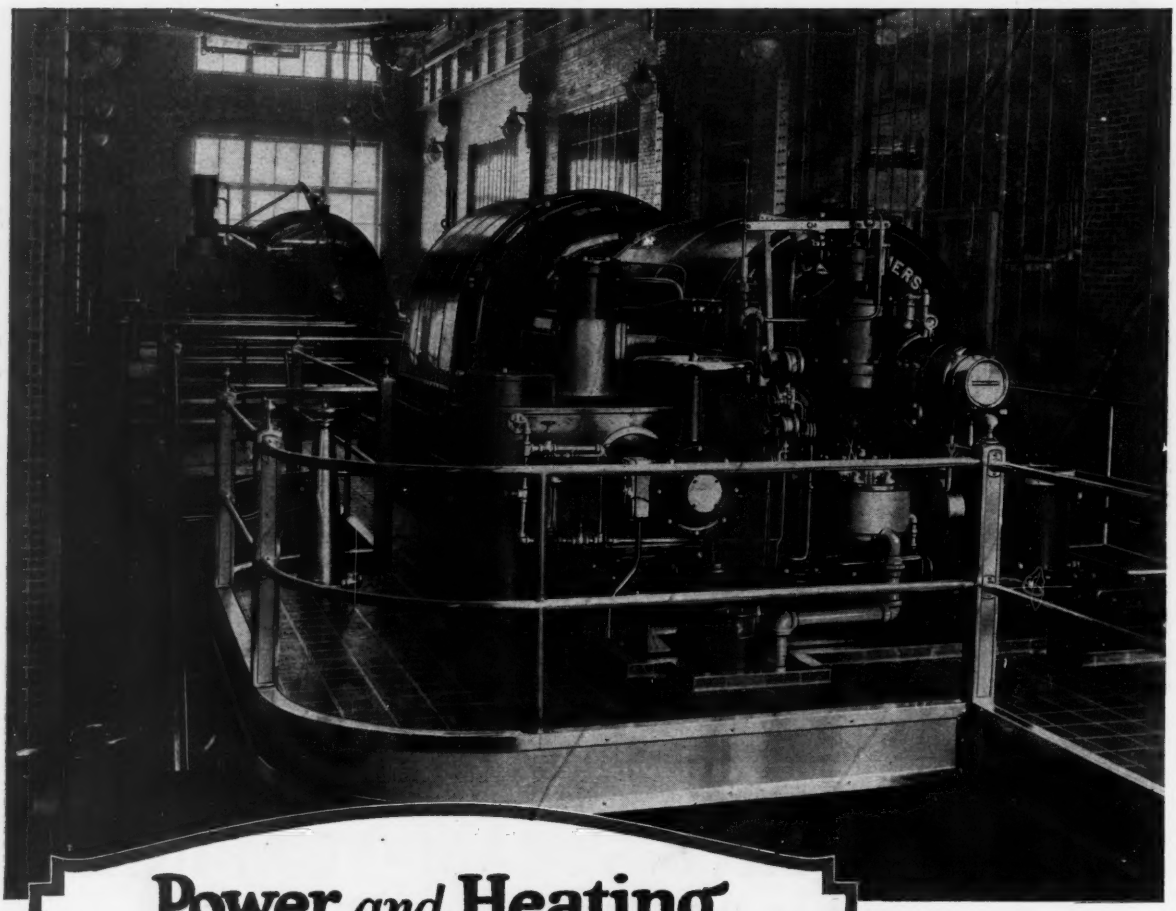

Power *and* Heating Efficiently Combined

The Power Plant of the Ford factory at Ford City, Ontario, economically combines power production throughout the year with winter heating.

Allis-Chalmers Steam Turbine Units were chosen for this unusual combination.

The two units of 10,000 K. W., and 5,000 K. W. rating, operate normally condensing, but when heat is required, the smaller unit operates with reduced vacuum, the warm circulating water delivering heat to the Plant.

Vacuum is reduced as heat requirements increase and provision is made for extracting additional steam from the larger unit during periods of severe cold. This arrangement meets heating requirements with a minimum of energy loss.

The turbine equipment making this high economy possible is the product of the Allis-Chalmers Organization, which is ready to serve you in any power problem. Additional details will be gladly furnished on request.

PRODUCTS

Steam Turbines
Hydraulic Turbines
Electrical Machinery
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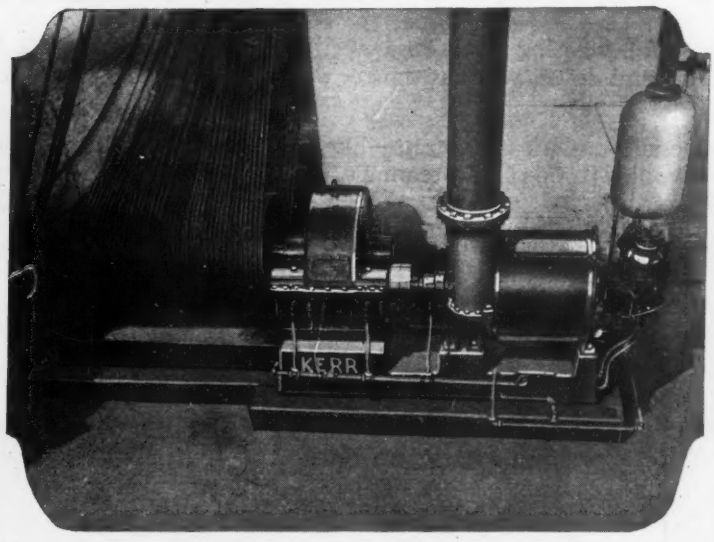
ALLIS-CHALMERS

MILWAUKEE, WIS., U. S. A.



600-hp. High Pressure Condensing Kerr Turbine driving rope sheave through Kerr Reduction Gears at The Hermitage Cotton Mills, Camden, S. C. Turbine speed of 3600 r.p.m. is reduced through the gear to 407 r.p.m.

KERR TURBINES

"Exceptionally Good Service"

The Kerr Turbine at The Hermitage Cotton Mills, put in operation in September, 1915, and operating continuously since, has given typical Kerr service. The installation has attracted attention as an unusual and novel application of rope drive.

A paragraph from a letter by Mr. R. B. Pitts, Pres. and Treas. of The Hermitage Mills, expresses the satisfaction he feels with the service of this machine—"In reference to our turbine, it may be of interest to you to know that from the time this turbine was installed in 1915 we have never opened the casing until last Saturday, December 16th.....We think the service rendered has been exceptionally good as the turbine has run night and day for a considerable portion of the time."

A sidelight on the rugged ability and dependable performance of this Kerr Turbine: A flood several years ago covered the Turbine with muddy water for about four and a half days; the water subsided on Wednesday night, the men cleaned up the exterior parts, and on Thursday morning turned steam into it. The Turbine started up and went ahead with the load until the regular week-end shutdown.

Kerr Turbines for Mechanical Drive

have been designed with utmost care to combine reliability and high efficiency. Among the features: Sturdy Shaft of special carbon steel; buckets of electric furnace nickel steel; rotor accurately balanced dynamically; carefully designed speed governor; separately actuated overspeed governor; heavy main bearings, each provided with two oil rings; large capacity oil reservoirs; etc.

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H-476

Heat cannot disturb the shaft

With the wheel casing supported at the center line, parts are free to expand, up and down, without danger of disturbing the alignment of the shaft.

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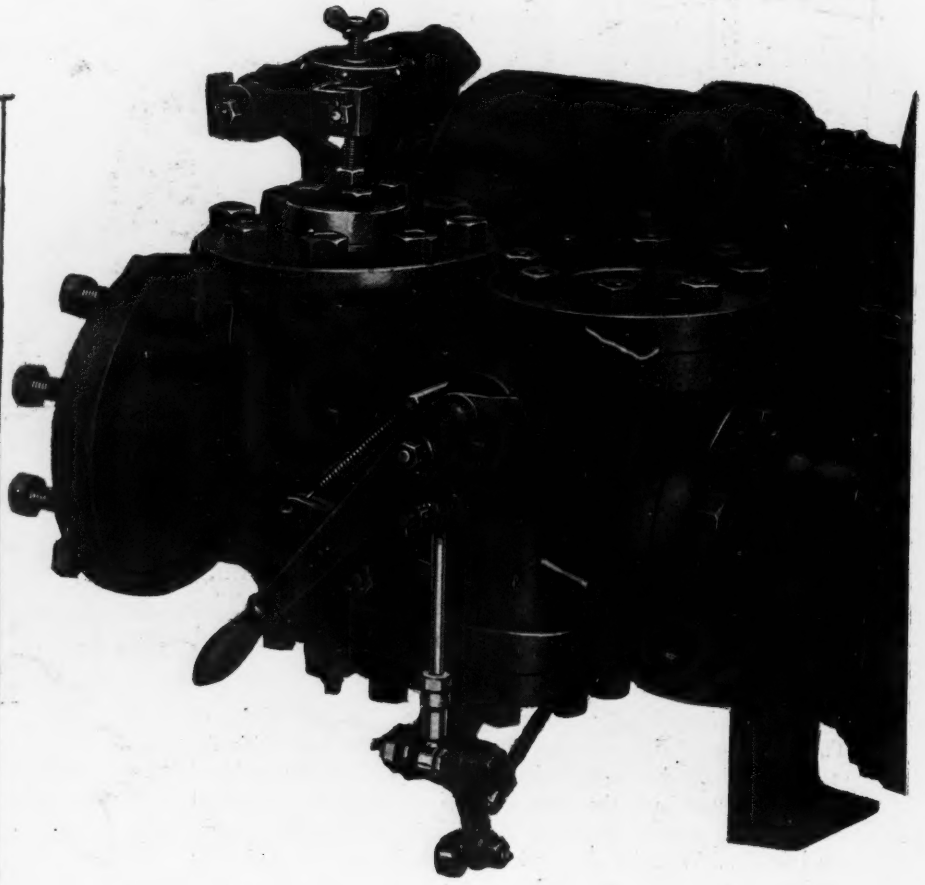

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